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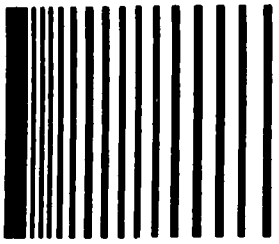

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SVIC NOTES

VOLUNTARY STANDARDS

With this issue of the **Shock and Vibration Digest,** we are inaugurating a new feature, a report on the status of national and international standards on mechanical shock and vibration. These reports will appear intermittently, and we are grateful to the Office of the Standards Secretariat of the Acoustical Society of America, which holds the secretariat for the Accredited National Standards Committee on Mechanical Shock and Vibration, for providing us with the information.

National voluntary standards may be developed by professional societies or trade associations, or they may be adopted from existing international standards. Historically, voluntary standards were developed to promote interchangeability, and this is still a major reason for developing standards. Our unified screw thread systems and electronic piece parts, such as resistors, capacitors, semiconductors, and the like, are familiar examples of our ability to freely interchange parts.

However, voluntary standards have been developed for other purposes; they help to promote uniformity and understanding. Almost all standards, regardless of their application, contain definitions of terms that are peculiar to the standard. These definitions help to promote uniformity by providing terms of common reference that can be understood and used by all. Very often, parts of a standard may be used to specify the desired characteristics of equipment in procurement actions. Just being aware of the existence of such standards can foster agreement between a manufacturer and an end user.

Voluntary standards often provide guidance defining good engineering practices in a given field, and such standards may often help those who may not be too familiar with a particular field. Consider the measurement of vibration of rotating machinery as an example. The construction of rotating machinery is diverse, and further, the construction of a machine governs the type of vibration measurements, the location of the vibration measurements and the measurement procedures. A standard for measuring machinery vibration would not only acquaint the novice with the proper methods for measuring the vibrations of different classes of rotating machinery, it might provide guidance on the range of vibration levels to be expected on various classes of rotating machinery, and it might also provide guidance for assessing the smoothness (or the roughness) of a machine's operation.

Many voluntary standards are related to system safety; they provide guidance for the safe design of systems, or they may specify the use of appropriate safety appliances on systems. Many of these safety standards have been adopted by regulatory agencies, and in some of these cases, they have the force of law behind them. The ASME Boiler and Pressure Vessel Code, which was first published in 1914, is a good example. At that time, boiler explosions occurred frequently; but today, because this code is widely used, boiler explosions are rare. (Interestingly enough, the number of boiler explosions declined dramatically in spite of increases in the maximum steam pressure to substantial levels.[1]

Safety standards have been developed within the shock and vibration community. The IEEE has developed guidelines for the seismic qualification of electrical equipment for nuclear reactor power plants.[2] (The Nuclear Regulatory Commission recognizes the use of this standard for the seismic qualification of electrical and mechanical nuclear power plant equipment in one of its own regulatory guides.) A safety standard, which is international in scope, provides guidelines for evaluating the human exposure to whole-body vibration.[3]

Voluntary standards serve many useful purposes in all fields. The development of voluntary standards is relatively new to the shock and vibration technical community. Hopefully, by publishing these reports, the shock and vibration community will become more aware of the existence and the uses of voluntary standards.

R.H.V.

[1] *Walters, S., "The Beginnings," Mechanical Engineering, 106 (4), pp 38-46 (April 1984)*

[2] *"IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," Standard 344-1975, The Institute of Electrical and Electronics Engineers, Inc., New York, NY (January 31, 1975)*

[3] *ISO Standard 2631, "Guide for the Evaluation of Human Exposure to Whole-Body Vibration," International Organization for Standardization (1972)*

EDITORS RATTLE SPACE

SOME OBSERVATIONS ON VIBRATION METERS

Several months ago I wrote on peak vs rms vibration measurements as a means for determining vibration severity in machines and structures. Basically comments were made on the meaning of overall vibration measurements and the controversy surrounding their use. No attempt was made to examine the state of the instrumentation used to make such measurements.

The two types of severity measures involve the use of peak indicating and true root mean square (rms) meters to process vibration signals from a transducer. Unfortunately most simple vibration meters sold today are neither true rms nor peak indicating. They are the same common vibration meter that indicates the average value of the signal or some multiple of it which has been sold for years. These meters give valid information, pertaining to the severity measures, for only sinusoidal signals. Therefore, if the vibration has simple harmonic content, the meter will provide useful information -- otherwise compromises are made. When vibration problems were mainly once-per-rev (mass unbalance or misalignment) the data obtained from the simple averaging meter was valid. But with the elimination of balance and misalignment as faults engineers expect to be able to deal with more complex vibration signals such as those obtained from rolling element bearing defects.

It is interesting to speculate why so few peak indicating and rms meters are available. It appears that the user has bypassed the simple meter for screening and analysis in favor of more sophisticated shock pulse, spike energy, and acoustic emission type meters -- in search of a quick cure all diagnostic tool. It is my opinion that a properly used modern meter could be just as effective as these devices; and, less expensive. The vendors as well as the users are responsible for this situation. The technician or engineer has to use what is available on the market. However, the user has the right to demand the simple modern meter and buy it from the few vendors who do offer it. Worse yet, a great deal of information is offered on the sophisticated devices but none on the meter.

It appears to me that with education and information the types of modern meters needed will appear on the market. The peak vs rms controversy shows that a determination needs to be made on which of the two measures are most effective. This is a minor issue compared to the unfortunate situation that exists -- a simple source of vibration information on machine condition is being bypassed because of lack of education.

R.L.E.

SOUND TRANSMISSION IN DUCTS

N. Romilly*

Abstract. ***This article describes the analysis of sound propagation in ducts or waveguides. Membrane and thin plate models are summarized, as is the normal mode method. Double panels and the importance of the accuracy of the panel model are covered. Experimental work and directions for future research are discussed.***

The subject of sound propagation in ducts or waveguides has been the subject of much investigation. The same applies to sound transmission through an unbounded layer; interest in this case is motivated by practical problems in acoustics.

Only in recent years has much attention been directed toward the synthesis of these problems although it is possible that the previous lack of work was due to difficulties in dealing with other-than-simple situations. Synthesis of the problems arises from the fact that, in any practical acoustical system, boundaries always exist. In the case of transmission through a wall of a room or test chamber, for example, it might be necessary to take the other walls into account. In addition, acoustical experiments on a smaller scale usually take place in some kind of waveguide.

In order to make progress in analyzing sound propagation in ducts it is necessary to have a simple model that does not neglect significant physical features. One such model is that of a panel occupying a cross section of a waveguide with a simple form. If this model can be analyzed, it might be possible to consider systematically the effects of altering such factors as configuration of the waveguide, material of the panel and the walls of the waveguide, and fixing conditions at the edges of the panel. Furthermore, the methods developed in the analysis of the simple model might be of value in dealing with new and more complex models.

Two waveguides that are convenient both for theory and experiment are a waveguide of circular cross section and one with parallel plane boundaries. Convenient models for the panel are a stretched ideal membrane or a thin elastic plate. On the one hand, in the case of the membrane, stiffness is neglected. On the other hand, in the case of the plate, tension is neglected. For the membrane the usual condition is that the edges are fixed. For the plate the edges can be clamped or simply supported. However, other conditions are possible. Even such simple models lead to fairly complicated analysis, however.

MEMBRANE MODEL

The formal solution in integral form to the problem of the transmission of a plane sound wave through an ideal stretched membrane in a rigid duct of arbitrary cross-sectional shape was found by Ingard [4]. He derived an approximate solution for transmission in a waveguide of circular cross section. This approximate solution predicted complete transmission or resonance at the frequencies of free vibration of the membrane. It also predicted frequencies of complete reflection, or anti-resonances. Ingard and Morse [5] later obtained an approximate solution by a variational method [5].

Romilly [6] found the exact solution in infinite series form for transmission of any axially symmetric incident sound wave through an ideal stretched membrane in a rigid circular waveguide. He showed that, for an incident plane wave, no exact resonances or anti-resonances exist above the cut off frequency of the first order waveguide mode. Below this frequency the resonances and anti-resonances differed from those predicted by approximate theories in a way that was algebraic but easy to compute. The correspondence between the solutions was reasonable when the speed of waves on the membrane was small

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compared with the speed of sound in the surrounding medium and when the density of the medium multiplied by the radius of the waveguide was small compared to the mass/unit area of membrane. A similar analysis applies to a parallel-plane waveguide.

THIN PLATE MODEL

Young [7] extended Ingard's work [4] and obtained an approximate solution for transmission of a plane wave through a thin elastic plate. Eichler and Lambert [8] also found an approximate solution for transmission of a particular sound wave thorugh a plate in a rectangular waveguide. Romilly [6] noted that the analysis used for the membrane could also be applied to a plate. In a later paper [9] he gave the exact solution to the problem of guided sound transmission through a panel exhibiting both stiffness and tension. Results for the important case of transmission of a plane wave were qualitatively similar to the case of an unstiffened membrane or a plate without tension. Perhaps contrary to expectation the effect of stiffness or tension was not solely to decrease the transmission of a plane wave but to decrease it at low frequencies while increasing it at higher frequencies. The difference in predicted transmission due to stiffness or tension was most marked in the neighborhood of resonance frequencies due to the shift of the resonance peaks.

The exact solutions had the advantage of being suitable for easy computation; they involved basically the summation of one infinite series that converged rapidly at low frequencies.

Sewell [10] used the solution or a clamped circular panel to obtain a transmission factor for a reverberant incident field; i.e. for a field produced by a uniform distribution of sources over a cross section of a duct. He remarked that the clamped edge might not be the appropriate condition to use in practice and that the edge conditions might be those of simple support.

Romilly [11] extended his previous analysis to obtain an exact solution for the transmission of any symmetric incident mode through a simply supported panel in a parallel-plane waveguide. A similar analysis applies to a simply-supported circular panel.

The results for a simply-supported panel were somewhat more complicated than those for a clamped panel but could be expressed in a form involving three singly infinite series. Results were again easy to obtain by computation particularly for the case of transmission of a plane wave. Transmission for the plane wave was qualitatively the same as for clamped boundaries. At low frequencies transmission was greater than for the corresponding clamped plate, but, as the frequency was increased, transmission became less than for the clamped plate. Quantitatively, the alteration in boundary conditions makes a considerable difference, particularly in the neighborhood of resonance peaks.

Flockton and Chapman [12] applied an earlier solution [6] to the problem of the transmission of a pulse through a cavity-backed circular plate in a cylindrical waveguide.

MATHEMATICAL METHODS

For single panels the prlbme can be formulated either in an integral equation form using Green's functions or in terms of normal mode theory. The integral equation approach is useful when approximate solutions are sought.

The exact solutions mentioned previously were obtained using the normal mode method, which is briefly as follows. The pressure in a waveguide is governed by the usual scalar wave equation. If waves of a particular frequency are considered, the pressure on each side of the panel can be expanded in a series of normal modes of the waveguide. These modes correspond to particular waves that could propagate along the waveguide with a particular frequency in the absence of the panel. The waveguide on one side of the panel contains incident and reflected modes. The other side is assumed to be either infinite or to be terminated by a perfect absorber, so that a transmitted wave travels in one direction. The driving pressure on the panel can be calculated from the pressures in the two parts of the waveguide. The driving pressure provides the forcing term in the equation of motion for the panel. This equation can be solved for the motion of the panel as the sum of a free vibration and a forced vibration. The arbitrary constants that occur in the free vibration can be determined in terms of the mode amplitudes of the waveguide using the edge conditions for the panel. When these constants are substituted back

into the expression for the panel motion and the condition that the velocity at each face of the panel must match the corresponding velocity of the fluid in the guide is utilized, the free motion of the panel is expanded in an infinite series of functions orthogonal over the cross section of the waveguide

The orthogonality of the modes is used to obtain an infinite set of equations that relate the amplitudes of the transmitted waveguide nodes to those of the incident nodes. Finally, the linearity of the equations is used to consider each incident node separately to reduce the problem of calculating the transmitted wave to that of inverting an infinite matrix. At this stage it is generally necessary to apply approximate methods. However, in the important cases mentioned previously, examination of the form of the matrix allows the exact inverse of the matrix to be found, thus, the exact solution specifying the transmitted wave for any symmetrical incident wave can be obtained.

The solution is in complex form; in order to separate the real and imaginary parts of the solution -- and thus calculate the transmission coefficients -- it is necessary to specify the particular frequency range being considered in terms of the cutoff frequencies of the waveguide modes. The solutions obtained are complicated functions of frequency involving the sums of one or more infinite series. However, the infinite series converge rapidly, and numerical results can readily be calculated. In particular, frequencies of complete transmission or reflection of a plane wave can be computed.

DOUBLE PANELS

Sound transmission through double panels is also a problem of theoretical and experimental importance. The unbounded case has been considered [13], but progress in the theory of bounded double partitions has been limited If the procedure for single panels is followed, the theoretical model would be two panels occupying cross sections of a waveguide. The theoretical treatment of this model would appear to be considerably more difficult than that for a single panel. Each mode incident on the first panel gives rise to an infinity of transmitted modes; each of these in turn gives rise to an infinity of reflected modes at the second panel. Each of the reflected modes at the second panel then give rise to an infinity of reflected modes at the first panel, and so on ad infinitum.

However, it has been shown by Romilly [14] that the exact solution of such a problem can in fact be found. An exact solution was obtained for the transmission of a symmetric sound wave through a double partition contained in a parallel-plane waveguide with rigid walls. A membrane model was used for the two leaves of the partition. A similar analysis would apply to the case of a cylindrical waveguide and should also apply when the leaves of the partition are elastic plates. The solution gives the transmitted wave corresponding to any incident mode in terms of six singly infinite series. It is not necessary to make any special assumptions regarding the parameters that describe the model. In particular no modifications are necessary for the region of the critical frequencies. For the important case of an incident plane wave the transmission coefficient is found in a form involving four real singly infinite series. The result is complicated, but, because the four series converge rapidly, the solution is suitable for computation. One interesting difference from the case of the single panel is that there are in general no frequencies of complete transmission or reflection of a plane wave for the double partition.

The mathematical method is similar to the single layer case but more complicated. The pressure in each of the three regions into which the panels divide the waveguide must be expanded in normal modes. The driving pressures on each panel can then be calculated. The forcing terms are in the equations of motion for the two panels; the motion of each panel can be expressed as a sum of free and forced motions. Arbitrary constant are determined by using the edge conditions for the panels. Continuity of fluid and panel velocity are applied at each panel, this continuity and the orthogonality of the modes yield systems of infinite equations that connect the mode amplitudes of the waveguide.

The linearity of the equations is again used to consider each incident mode separately The amplitudes of the modes in the region between the panels are eliminated from the equations. This elimination as well as additional manipulation eventually reduce the problem of calculating the transmitted wave to that of inverting an infinite matrix In the proc ss

of this reduction, however, it is necessary to invert another simpler infinite matrix. The final matrix obtained is more complicated than in the single panel case; in addition, the terms of the matrix themselves contain an infinite series. It is remarkable that examination of the form of this matrix again allows the exact inverse to be obtained; this exact inverse provides the exact solution specifying the transmitted wave for any symmetrical incident wave. The solution again involves a number of infinite series and is in complex form, so that the particular frequency range must be specified in order that real and imaginary parts may be calculated.

THE PANEL MODEL

It is of great importance both for the theory and for comparison with experiments to consider the accuracy of the model used for the panel. Ideally it would be desirable in the case of a solid layer to approach the problem on the basis of the exact equations of linear elasticity. The solution would be to the problem of sound transmission through an elastic layer contained in a duct. Such a solution has been obtained for only one case [15] -- when the boundaries are rigid and lubricated. In the absence of other exact solutions the problem can only be handled using approximations such as the classical thin plate theory for the layer. Questions then arise with regard to the range of frequencies for which the model is accurate and the degree of accuracy of the approximation. In this connection it can be remarked that the theory of the vibration of plates does not seem to be as satisfactory as that of thin rods. In the case of rods the approximate theories can be compared with and based on the exact Pochhammer-Chree solution for the longitudinal vibration of rods [16]. Romilly [17-20] recently attempted to compare predictions of classical thin-plate theory with an exact solution for vibration of a plate of arbitrary thickness. Certain as-yet-unexplained discrepancies arose, and there is clearly a need for further study of the theory.

EXPERIMENTAL WORK AND FUTURE RESEARCH DIRECTIONS

A number of references mentioned previously contain details of experimental work. Ingard [4] carried out experiments on transmission through a membrane in a cylindrical duct; Young [7] extended this work to transmission through a plate. Eichler and Lambert [8] carried out experiments on transmission through a plate in a rectangular duct. Sewell [10] gave results regarding transmission through brick. Flockton and Chapman [12] studied transmission of a pulse through cavity-backed panels in a cylindrical duct. Generally good agreement between theory and experiment was obtained for low-frequency transmission of plane waves through a single panel. Further experimental work on transmission through a single panel of higher modes and plane waves at higher frequency would be of value. Also of interest would be further theoretical work on other forms of guide, types of panel, and edge conditions. Further study of the thin plate model is needed.

Little experimental work exists for double panels. As regards theory further study of the implications of the exact solution for the membrane model of the panels would be of interest together with extension of the work to the plate model of the panels.

Very little experimental or theoretical work has been done on sound transmission through thick panels contained in ducts; these problems provide many possibilities for future work. However, the formidable theoretical problems involved will make progress difficult.

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains an article about approximate methods for determining the vibrational modes of membranes.

Dr. J. Mazumdar of the Department of Applied Mathematics, The University of Adelaide, South Australia has written a review updating three previous reviews on the same subject published in 1975, 1979, and 1982. It supplements the earlier reviews and covers only work reported in the literature since the publication of the last review in this sequel. Recent research dealing with free and forced vibrations, nonlinear effects, and other complicating factors is summarized.

A REVIEW OF APPROXIMATE METHODS FOR DETERMINING THE VIBRATIONAL MODES OF MEMBRANES

J. Mazumdar*

Abstract. ***This review updates three previous reviews on the same subject published in 1975, 1979, and 1982. It supplements the earlier reviews and covers only work reported in the literature since the publication of the last review in this sequel. Recent research dealing with free and forced vibrations, nonlinear effects, and other complicating factors is summarized. The reader should acquire the previous reviews for a reasonably complete coverage of this specialized topic.***

Membranes are extensively used in modern high-speed aircraft, bridges, ships, and even space vehicles. For design purposes it is essential to employ an accurate analysis to predict linear and nonlinear material response, large and small deformations, and static as well as dynamic behavior of structural elements.

It is well known that the problem of transverse vibration of a membrane is one of the classical eigenvalue problems in mathematical physics. In the simple case of free vibration it can be described by the homogeneous Helmholtz equation of the form

$$\nabla W + \lambda W = 0 \qquad (1)$$

However, this innocently posed simple equation has no simple solution if the boundary of the domain is not natural to one of the common coordinate systems. Hence there arises, even in the simple case of free vibration, the need to use approximate methods for solving boundary value problems in membrane analysis. In other cases of membrane vibration, problems are much more complex, and the choice of a suitable approximate method is not obvious. Numerous technical criteria should be evaluated before a solution is attempted. The open literature contains more and more new types of approximate methods, and the object of the present review is to summarize them.

This review, like earlier ones [38], describes both linear and nonlinear analysis. The effects of such complicating factors as large amplitude vibrations, material anisotropy, dynamic loading, and disturbed forcing functions are also included. An indication of future study is also proposed.

LINEAR ANALYSES

For convenience of treatment the two classes o linear analyses, namely free vibrations and force vibrations, are considered separately. Their coexistence is also physically possible, however.

Free Vibration Analysis

It is well known that the natural frequencies of free vibration of a membrane can serve as a useful index for such related problems as the oscillatory motion of an enclosed body of water, axial shear vibration of a long elastic bar, wave propagation in a uniform hollow waveguide filled with a homogeneous isotropic dielectric, and unsteady motion of incompressible fluids in a duct. The reason is that all of these problems are classified as one type of boundary value problem in mathematical physics. Some of these problems have been extensively studied; many analogous membrane problems have thus been solved when these problems were solved.

The eigenvalue problem corresponding to free vibration of a membrane has a long history, and many mathematicians and physicists are still actively working in this field. When the shape of a membrane has corners, singularity of the eigenfunctions arises at them, thus creating problems for accurate determination of the eigenvalue. In the case of a membrane in the shape of a polygon, no exact solution is found in the literature. A number of researchers have recently attempted to obtain accurate approxi-

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mate solutions of such problems. Descloux and Tolley [10] used a large singular finite element method to derive the eigenvalues for L-shaped, half L-shaped, and a general polygonal-shaped membrane without symmetry. They also derived, with the help of the collocation method, results for symmetric eigenfunctions of a square membrane.

Bettess [4] also studied the eigenvalue problem for a regular polygon. The domain of the polygon was first mapped onto a circle; the analytical solution for the circle was then obtained in terms of Bessell functions. Reasonably good approximations to the lowest eigenvalues for triangle, square, regular pentagon, and regular hexagon were obtained.

In a series of interesting papers, Irie et al [21-27] studied free vibrations of polygonal-shaped membranes. The domain of the membrane was transformed into a square membrane of unit length by a certain transformation of variables [21, 24]. Using strings functions, which are analogous to beam functions in plate problems, they derived the frequency equation by the Ritz method. A regular polygonal membrane was formed on a rectangular membrane by fixing several segments [22], and the natural frequencies and mode shapes were determined using a Fourier sine series expansion technique. The method was applied to an equilateral triangular through a regular decagonal membrane. The same approach was used to present the natural frequencies and mode shapes for cross-shaped, I-shaped, and L-shaped membranes [25]. Frequency equations were also presented for hexagonal and octagonal membranes [23].

Free vibration of circular-shaped membranes of rectangular orthotropy was also studied [26]. Green's function and the Fourier series approach were used to calculate the natural frequencies and mode shapes. A conformal mapping approach was used in conjunction with the Ritz method to determine eigenvalues for several modes of vibrations of square membranes with rounded corners [27].

Subsequently, Laura et al [33] proposed an interesting alternative method for this type of problem based on a conformal mapping approach and using polynomial coordinate functions. In another interesting paper the same group [31] showed that the finite element method yields results that are in very good agreement with values determined by an analytical approach for a membrane of a cardiodal shape. The same problem has also been discussed [30] with the Fourier expansion-collocation method and the finite element method.

A simple, approximate method for solution of the Helmholtz equation in the case of rectangular, nonhomogeneous domains has recently been proposed [32]. Two other interesting studies for a nonhomogeneous membrane of circular shape have been published [9, 47]. In one case [47] the authors found the upper and lower bounds for the natural frequencies of a circular membrane with stepped radial density. An eigenvalue estimation technique based on an integral equation method was used. De [9], on the other hand, used the Rayleigh-Ritz method to study the transverse vibration of a nonhomogeneous circular membrane when density is a function of radial distance. Frequencies decreased with increasing density. The concept of homogeneity within the framework of a hyperelastic anisotropic membrane has also been dealt with [7, 8].

In the case of skew geometry, the method of separation of variables commonly used for circular and rectangular geometry is not applicable; therefore, not much work on the dynamic behavior of skew-shaped membranes can be found in the literature. However, a good approximate solution for the vibration of a parallelogram membrane was obtained when the basic equation of motion was expressed in oblique coordinates [3]. The natural frequencies of oblique membranes for various values of aspect ratios were also evaluated.

An analytical method based on the transformation of cylindrical wave functions has been used [34] to study free vibrations of a uniform circular membrane with eccentric holes. The governing wave equation was solved exactly to satisfy the boundary conditions at both inner and outer edges, and the associated frequency equation was derived. The dependence of the eigenfrequency on eccentricity and on the ratio of inner to outer radius was also discussed.

The problem of finding the equilibrium configuration of membranes of various shapes, stretched over a plane frame, has also been considered [5]. However, many simplified assumptions were made.

The study of wrinkle lines on the surface of a membrane has also been a subject of recent study [35, 40]. Mansfield [35] presented a theory for the behavior under self-weight of an inextensible but perfectly flexible membrane. Slack in the membrane manifested itself by forming curved wrinkle lines the determination of which was the prime objective. It was shown that the wrinkle lines satisfy the one-dimensional diffusion equation. A generalization and numerical implementation of the Stein-Hedgepath continuum for the analysis of partly wrinkled membranes has been presented [40]. A finite element analysis approach was used.

A problem that has been of interest in recent years has to do with the shape design criteria of a membrane. Rousselet [44] obtained a transformation function to determine the shape of a membrane. Differential operator properties and transformation techniques of integral calculus were utilized to indicate that the response and the eigenvalues depend in a continuous and differentiable way on the shape of the membrane. This problem has also been studied [15] with the help of zeros of the eigenvalue equation containing Bessel functions. The case of a vibrating annular membrane with fixed edges was considered, its area, perimeter, and connectivity were extracted explicitly.

Another contribution to the subject of free vibration is that of Dudnik and Ekimov [11], who proposed an algorithm for determining the parameters of vibrating membranes. They based the algorithm on the application of similarity criteria of the problem of vibrations of membranes in an elastic medium.

Forced Vibration

When a membrane is driven by a force distributed over its surface, forced vibration results. The literature dealing with such problems is very limited because of the mathematical complexity of the forcing function.

The usual procedure for analyzing forced vibration problems of such continuous systems as membranes, plates, and shells is to express the forcing function in terms of the eigenfunctions of the corresponding free vibration; amplitude and time response of each mode are obtained. This normal mode expansion approach has recently been used in a series of papers by Mazumdar and co-workers [16-19, 39] on the study of human aortic and mitral heart valve leaflets, the results are useful for clinical utilization of a prosthetic heart valve.

The forced vibration of membranes has also been studied by Gottlieb [13, 14]. He investigated the effect of the compressibility of the enclosed air on the natural vibration frequencies of an annular and rectangular drum. The ratio of frequencies of higher modes to the first mode in the case of an annular membrane was always a little greater than an exact integer.

Baur [3] discussed the forced vibration of a parallelogram membrane when it is subjected to a load and a number of concentrated forces. He used Lagrange's energy principle expressed in oblique coordinates.

NONLINEAR ANALYSIS

A number of interesting papers on nonlinear vibrations have recently appeared in the literature, but they are mostly confined to circular membranes. Nonlinear axisymmetric dynamic response of a circular membrane due to harmonic excitation close to one of the primary resonance points has recently been studied [50]. The symmetrical deformation of circular membranes under the action of uniformly distributed loads in their central portion has been discussed [6] using Hencky's method of solution. The problem of impulsively loaded circular membranes of viscoplastic material has also been discussed [20]. The linearized theory of thin viscoelastic shells was used, and results were compared with other approximate solutions of the same problem based on the method of quasi-iteration and perturbation.

Nowinski [31] derived general equations of motion for nonlinear transverse vibrations in membrane-like spinning disks. A harmonic-type wave was studied that corresponded to the gravest mode in the linear case. The frequency-amplitude relation was discussed using the Galerkin procedure. In another study Nowinski [42] analyzed the motion of a rotating anisotropic membrane-like disk assuming a particular form of deflection surface. The stability of motion for a specific mode and a particular choice of temporal perturbation was discussed.

An exact solution has been given of the nonlinear equations for the large deflection behavior of an initially unstretched annular membrane under axial load [2]. A similar problem with a concentrated load applied along its axis of revolution was discussed using variational methods [1].

Longitudinal vibrations of an axisymmetrically deformed circular membrane of Mooney material have been considered [48]. Numerical solutions were obtained for approximate mathematical equations. Dependence of the frequency parameter and its maximum deflection were also presented.

In a purely theoretical study Matsikoudi-Iliopoulou [36] presented a mathematical model for finite deformations of membranes using material surface coordinates. he introduced a surface strain energy density function. The model was applied in a subsequent paper [37] to finite deformations of axisymmetric membranes of Mooney-Rivlin type material. Linearized solutions were given. Vaughan [49] also studied Mooney-type material for a circular membrane using a power series method.

EXPERIMENTAL METHODS

Although theoretical aspects of the vibration of a membrane have been studied intensely, not much work on experimental investigation can be found in the literature. A recent study of multi-mode response of a circular membrane is that of Yasuda and Uno [50]. The authors conducted experiments close to the second primary resonance points to check the accuracy of their theoretical results. They used a thin steel plate and applied excitations with two electromagnets. The oscillations induced in the membrane were measured by two displacement sensors.

It is known that experimental methods currently available are applicable primarily to deformation on flat surfaces. An interesting method has been described recently by Seliutin [45, 46] for measuring deformations of membranes He used a dividing network in a large toolmaker's microscope that will record the deformation at any point under continuous loading with an accuracy of 0.01 mm.

Membranes rigidly fixed in outline and loaded with a transverse hydrostatic pressure are frequently used as protective diaphragms when vessels are tested under pressure. An experimental study for the design of safety membranes made of aluminium and copper has been reported [28]. Various experimental data were also presented

PRACTICAL APPLICATIONS

The practical applications of membranes are well known. Membranes are extensively used in machine design for transducers, pressure instruments, pumps, and compressors. Many missiles have thin membranous lateral bulkheads that are subjected to force motions in flight. Membranes are also used in many musical instruments, in which they allow energy to be transformed.

In an interesting paper on the physics on kettledrums, Rossing [43] demonstrated the value of a knowledge of membrane vibration in the study of kettledrum acoustics. The author showed that, in the case of a kettledrum, the inharmonic modes of an ideal membrane are coaxed by the effect of air-mass loading into a harmonic relationship. The drumhead frequencies are further tuned by the air enclosed in the kettle and by the stiffness in shear of the membrane. These are also typical properties of other musical instruments including the Indian Tabla, which is a small hand-struck drum.

The theory of membrane vibrations has recently been applied in the field of biomechanics to study certain human component models [12, 16-19, 39]. Mathematical models of heart valves and heart sounds have resulted in quantitative guidelines for assessment of valvular pathology and malfunctioning of prosthetic heart valves. Kuttler and Sigilito [30] have also demonstrated the practical applications of membrane vibration analysis to the study of heart valves and waveguides. They, in fact, obtained membrane frequencies in the shape of a Limacon and in a special case a cardiod.

FUTURE RESEARCH DIRECTIONS

It is clear that, although reasonably good quality research on membrane vibration has been undertaken recently, much remains to be done. First, a systematic comparative study of nonlinear membrane prob-

lems -- particularly noncircular geometry -- warrants attention. Second, membranes with anisotropic and nonhomogeneous material properties are a worthwhile subject for future study. It is also hoped that, in future years, the fascinating subject of the physics of drums in general will receive more attention because the acoustical properties of most other drums, except kettledrums [43], have not yet been carefully investigated. A notable exception, of course, is pioneering work of the eminent physicist C.V. Raman on the modes of the Indian tabla. Also, there still exists the need for extensive experimental work to validate theoretical results and to provide direction for further investigation.

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BOOK REVIEWS

ROTOR DYNAMIC INSTABILITY

M.L. Adams, Jr., Ed.
ASME, New York, NY
AMD-Vol. 55, 1983, 96 pages

Rotor dynamics plays an important role in the stability of such rotating machinery as centrifugal pumps, Francis hydroturbines, and steam and gas turbines.

This volume contains papers of a symposium held in June, 1983. The sponsors attempted to present current research slanted toward better understanding the dynamic interaction between stator and rotor. Interaction between rotor and stator forces can cause instability of a rotor system.

This symposium consists of nine papers, of which three are abstracts. The initial paper discusses the physical nature of rotor instability mechanisms, including internal damping within a rotor that deforms, coupling of a rotor with external or internal fluids, and exits from axial symmetry of the elastic properties of a rotor.

The next paper presents an experimental investigation of air labyrinth seal forces on a subsynchronous whirling model. Pressure drop, back pressure, whirl direction, and wheel frequency play important roles in self-excited whirl of turbine rotors and other machines with labyrinth seals. The total dynamic seal forces and whirling pressures in the seal annulus are measured and compared with total measured forces. Results show that either radial and axial pressure gradients in the seal annulus or drag forces in the rotor are important.

The third paper is an abstract of rotor instability cases in large steam turbines/generators. The next paper, also an abstract, is concerned with the effects of different rub models in rotor dynamics.

The fifth paper describes the influence of unbalance on the nonlinear dynamic response and stability of flexible rotor/bearing systems from both experimental and theoretical aspects. In actual cases, amplitudes can be bounded due to various nonlinearities; the result is limit cycles of motion, in contrast to textbook cases of linear systems operating above the stability threshold. Nonlinearities in fluid bearings and seals are accompanied by nonlinear effects on shafts, couplings, and flexible foundations. These nonlinear events can induce jump phenomena of critical speeds and stability and restabilization speeds.

The next paper focuses upon design criteria for improved stability of centrifugal compressors. Stability theory, as applied to current compressor design theory is reviewed, as are development criteria. Experience of the designer plays an important role in design criteria.

The seventh paper, which is an abstract, has to do with measurement of stiffness and damping matrices of centrifugal pump impellers. The most significant feature of these matrices is that the off-diagonal terms indicate skew symmetry. The reviewer believes that this is significant work, but an evaluation of the complete paper is not possible.

The eighth paper is a continuation of previous work by the authors and describes perturbation tests of bearings to determine oil whirl characteristics for evaluating dynamic coefficients. Perturbation of a well-balanced shaft rotating at constant speed in a test journal oil bearing induces an important fluid inertia effect and results in negative values of the bearing stiffness coefficient. By experimental means, the authors verify a theoretical relationship among tangential damping, radial stiffness coefficients, and fluid inertia of the bearing.

The last paper reports on case studies of rotor instability of turbines and low-speed centrifugal air compressors in the utility industry. With the advent of modern electronic equipment, the utility industry has solved a number of practical problems that have plagued it.

The reviewer was disappointed that all papers could not be published. Papers on steam whirl, effects of cracks on rotor stability, and aeroelastic effects on turbomachinery and squeeze-film dampers (theory and experiment) would have added to the symposium.

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PROBABILISTIC METHODS IN THE THEORY OF STRUCTURES

I. Elishakoff
John Wiley & Sons, New York, NY
1983, 489 pages

This book attempts to relate the probabilistic approach to static analysis, random vibration, and random buckling of a beam. The author describes probabilistic axioms, single and multiple random variables, probability distribution, density functions, the theory of random functions, and random vibration. Although some of the subjects are not closely associated with probabilistic theory, the author ties together reliability, random vibration, and random buckling.

The book consists of 11 chapters and five appendices. Chapter 1 introduces the subject of probability as it is applied to structures and contains an excellent bibliography. Chapter 2 describes probability axioms, including probability and relative frequency, conditional probability, overall probability, and Bayes formula. Chapter 3 begins with random variables and descriptions and properties of distribution functions. Additional topics include mathematical expectation, variance and conditional probability distribution, and density functions. The chapter concludes with inequalities of Bienayme and Tchebycheff. Chapter 4 contains examples of probability distribution and density functions for a single random variable and includes such distributions as binomial, Bernoulli, Poisson, Rayleigh, exponential, chi-square, gamma, Weibull, Gaussian, and truncated normal. Other sections of this chapter consider the functions of a random variable (distribution and density functions), exponents, and logarithms of random variables. An example of a probabilistic approach to an engineering decision problem is given.

Chapter 5 introduces reliability of structures described by a single random variable. Included are a bar under random force, a beam under a random distributed force, and axial impact of a bar with an initial random imperfection. Static and dynamic sensitivities of a nonlinear structural model are also considered.

Chapter 6 has to do with two or more random variables. These are joint distribution and joint density function of two random variables, conditional probability distribution and density functions, plus functions of a random variable. Important expected values, moments, covariance, joint characteristic functions, and several jointly normal random variables are described, as are functions of random variables and complex random variables. In Chapter 7 reliability of structures is described by several random variables. Examples of the bending of a beam under several concentrated random forces and moments and central limit theory and reliability estimate are given.

Chapter 8 covers the theory of random functions, including definitions of a random function, first and second order distributions, and moment functions. Properties of the covariance function, the probability density function, joint distribution, and complex and stationary random functions are also described, as are spectral density, differentiation, ergodicity, and integration of random functions.

Chapter 9 focuses upon random vibration of discrete systems. A description of the response of linear systems subjected to deterministic excitation includes the convolution integral. The response of linear and multi-degree-of-freedom systems subjected to random excitation and the role of modal cross correlation in random vibration are included. This chapter is well written and fully explained.

The next chapter has to do with random vibration of continuous structures. Random fields, an example of a plate under distributed loading, and the normal mode method and joint and cross acceptances are described. The latter are usually omitted in books on random vibration of beams. The author presents

an interesting discussion of random vibration due to boundary layer turbulence and analytical approximations for pressure fluctuations in a turbulent boundary layer. He concludes the chapter with use of approximate methods for problems of flutter and random vibration of beams. The reviewer believes this chapter is too condensed.

The concluding chapter concisely describes application of the Monte Carlo method to the simulation and generation of random numbers, variables, and vectors. Simulation of random functions and buckling of a bar on a nonlinear foundation are also given.

The reviewer feels that a table of nomenclature would be a great asset. Chapters on random fatigue plus cepstrum analysis and the Hilbert transform should be included. A chapter on data processing of random vibration and acoustics would be welcome as would some computer programs describing the application of random vibration to plates and beams under various end conditions. The reviewer believes that a section on Fokker-Planck equations and the Chapman-Kolmogorov-Smoluckowski equation should be included. For those interested in stochastic processes applied to structural mechanics, however, this is a useful book.

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INTRODUCTION TO RANDOM VIBRATIONS

N.C. Nigam
MIT Press, Cambridge, MA
1983, 360 pages, $35.00

This volume, the first of two the author is preparing on random vibrations, is concerned mostly with the development and discussion of theoretical aspects. The second volume, to be released sometime in 1984, will treat applications of the theory. Professor Nigam wrote this book to be used either as a text for graduate students or as a reference for those in practice.

Approximately half of the 340 pages are concerned with mathematical aspects of random theory, including basics of probability and random variables and processes. Each of the six chapters in this half is well written; the author clearly explains the theory in the text and includes several exercises. However, the theory is complex and purely mathematical. Einstein notation is used at times without any introduction; thus the reader is required to know to some extent most of the material presented beforehand. Although graduate students, or others learning in a structured manner, will probably find this constraint minimal, I doubt if the practicing engineer out of school several years will find this approach comfortable. Nevertheless, the patient and knowledgeable reader will find this part of the book a self-contained text on random theory.

The first half of the book sets the stage for the second half, which is concerned with vibrations: the general response of a system to random excitation, continuous linear and discrete systems, and nonlinear systems. Professor Nigam's treatment of vibrations is classically applied mathematics in that his explanations are derived and discussed in a mathematical rather than a physical sense. This in no way diminishes from the value of the book for certain readers, especially those well versed in the traditional derivations of equations of motion for discrete and continuous systems; for such readers the text is an illuminating treatment of random vibration. However, for the reader who needs answers rather than methods, these sections might be a disappointment.

The last chapter on the response of nonlinear systems is extremely useful and well written. Descriptions are given of various techniques including approximations to the Fokker-Planck equation (iteration, Eigenfunction expansion, Galerkin method, and others), the perturbation method, and equivalent linearization. I suggest that readers of this chapter understand the complexities of nonlinear analysis in deterministic systems prior to attempting to review these random-excited problems. This section, and others in the last half of the book, are definitely not stand-alone.

The author does an impressive job of explaining in a single volume the theory of random vibrations. He provides a comprehensive review of the mathematics involved from theory to system response and exhaustive listings of up-to-date references. He includes three valuable appendices on Fourier analysis, on

ordinary differential equations, and on responses of linear single-degree-of-freedom systems to random excitation. Professor Nigam has written an excellent graduate level text for students and researchers. Whether it will be useful for practicing engineers depends greatly on their background in both applied mechanics and mathematics.

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MODELING, ANALYSIS, AND CONTROL OF DYNAMIC SYSTEMS

W.J. Palm, III
John Wiley & Sons, New York, NY
1983, 740 pages, $36.95

This excellent introductory textbook on dynamic systems and control is intended for undergraduates in mechanical engineering and other engineering disciplines. It is carefully structured and well written; the style is clear and concise. Topics are introduced with precise definitions, interesting examples from diverse fields, and historical sketches. The theory and application are clearly presented and supplemented with meaningful problems. A summary is given at the end of each chapter. This book is a gift to the student. Its vast scope is indicated by the list of major topics of each chapter given below.

Chapter 1: Introduction

Systems; Modeling, Analysis, and Control; Types of Models (Lumped- and Distributed-Parameter Models, Linear and Nonlinear Models, Time-Variant Models, Discrete- and Continuous-Time Models, Stochastic Models); Linearization; Feedback

Chapter 2: Modeling of Dynamic Systems

Model Development Using Integral Causality; The Constitutive Relations: Resistance, Capacitance, and Inductance; Mechanical Systems; Electrical Systems; Liquid Level Systems and Pipe Flow; Hydraulic Devices; Pneumatic Elements; Thermal Systems, Models of Nontechnical Systems (Natural-Resource Management, Biomedical Applications, Socioeconomic Models)

Chapter 3. Analysis of Continuous-Time Models

Free Response of the Linear Model (Point Equilibrium and Stability, Parameter Estimation), Response to a Step Unit; Laplace Transform Solution of Differential Equations; Transfer Functions and Block Diagrams, The Initial and Final Value Theorems, Signal Flow Graphs, Impedance and Transfer Functions; Frequency Response; Bandwidth and Periodic Inputs; Nonlinear Models, Linearization of Dynamic Models; Numerical Methods: An Introduction; Advanced Numerical Methods

Chapter 4: Discrete-Time Models and Sampled-Data Systems

Origin of Discrete-Time Models; Free Response; Sampling; The z-Transform; The Transfer Function and System Response; Sampled-Data Systems; Digital Filtering: Time-Domain Analysis; Frequency Response of Discrete Systems; Inverse Operators. The Tustin Method

Chapter 5: Analysis of Higher Order Systems

Origin of Higher-Order Models; Forms of the Continuous-Time Model; Free Response; The Characteristic Equation; the Routh-Hurwitz Stability Criterion; The Transition Matrix; Step Response; Impulse and Ramp Response; Frequency Response; Nonlinear Higher-Order Systems; Discrete-Time Models of Higher Order; Discrete Time Response

Chapter 6: Feedback-Control Systems

Feedback Control: Concepts, History, and Applications; Control System Structure; Transducers and Error Detectors; Actuators; Control Laws; Integral Control; Derivative Control; Electronic Controllers; Pneumatic Controllers; Hydraulic Controllers; Digital Implementation and Control Algorithms; Development of Control Law from the Analog Form

Chapter 7: Control System Design: Modeling Considerations, Compensation, and Alternate Control Structures

Selection of Controller Gains; Design with Low-Order Models; Nonlinearities and Controller Performance; Compensation; State-Variable Feedback; Pseudo-Derivative Feedback; Interacting Control Loops; Some Advantages of Digital Control

Chapter 8: Graphical Design Methods: The Root-Locus, Nyquist, and Bode Plots

The Root-Locus Concept; Plotting Guides; Some Numerical Aids; Response Calculations from the Root Locus; The Complementary Root Locus; Root Locus for Systems with Dead-Time Elements; System Design with Open-Loop Frequency-Response Plots; Series Compensation and PID Control; Lead and Lag Compensation; Applications to Digital Control

Chapter 9: Advanced Matrix Methods for Dynamic Systems Analysis

Examples of Matrix Models; Vector Representations of the Free Response: System Modes; The Transition Matrix; Controllability and Observability; Matrix Analysis of Discrete-Time Systems

Chapter 10: Matrix Methods for Control System Design

Vector Formulation of State-Variable Feedback; State Vector Observers; Regulator Design with a Quadratic Performance Index; Matrix Methods for Digital Control

Six Appendices address the following topics: Some Useful Analytical Techniques; The Laplace Transform; A Runge-Kutta Subroutine; Mason's Rule for Diagram Reduction; Simulation with an Analog Computer; The Routh-Hurwitz Criterion: The General Case.

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STANDARDS NEWS

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American National Standards (ANSI Standards) in the areas of physical acoustics, bioacoustics, mechanical shock and vibration, and noise are published by the Acoustical Society of America (ASA). In addition to these standards, other Acoustical Society standards, a Catalog of Acoustical Standards—ASA Catalog 4-1983, and an Index to Noise Standards–ASA STDS Index 2-1980 (national and international) are available from the Standards Secretariat of the Acoustical Society. To obtain a current list of standards available from the Acoustical Society, write to Avril Brenig, at the above address. Telephone number: (212) 661-9404

Calendar

The Fall meetings of the ASA standards committees will be held 8–11 October in Minneapolis, Minnesota.

1984 October 08. ASA Committee on Standards, 7:30 p.m., the Leamington Hotel, Minneapolis, Minnesota. Meeting of the Committee that directs the ASA Standards Program.

1984 October 10. Accredited Standards Committee S2 on Mechanical Shock and Vibration (also Technical Advisory Group for ISO/TC/108 and IEC/SC/50A), 2:00 p.m., The Leamington Hotel, Minneapolis, Minnesota. Review of international and S12 activities and planning for future meetings.

1984 October 11. Accredited Standards Committee S12 on Noise (also Technical Advisory Group for ISO/TC43/SC1), 9:30 a.m., The Leamington Hotel, Minneapolis, Minnesota. Review of international and S12 activities and planning for future meetings.

1984 October 11. Accredited Standards Committees S1 (Acoustics) and S3 (Bioacoustics) (also Technical Advisory Group for ISO/TC/43, IEC/TC/29, and IEC/TC108/SC4) at 1:30 p.m. at the Leamington Hotel, Minneapolis, Minnesota. The S1 meeting will be held first. Review of S1, S3, and international standards activities and planning for future meetings.

Editorial—Standards News and the Acoustical Society of America

Starting with this issue (July) of *Standards News* and in the March and November issues, the Associate Editors of *Standard News* will present editorials on important issues facing the standards' community and the ASA. In addition, we have standardized (as characteristic of those interested in standards) the format of the *Standards News* section of the *Journal*. We hope that both of these changes will improve the readability of *Standards News*. The purpose of this section of the *Journal* is to inform the readers about the important events associated with the Society's participation in national and international standards. The majority of standards work in the United States is performed on a voluntary basis. The work on standards is done by the Acoustical Society of America Committee on Standards (ASACOS) and by the four Accredited Standards Committees (S1, S2, S3, and S12) and their working groups. These committees involve hundreds of Society members who volunteer many hours to produce acoustical standards used in the United States and internationally. The Society supports this effort largely through the Standards Secretariat office headed by the Standards Manager, Dr. Avril Brenig. The Standards Secretariat is an office of the Acoustical Society of America located in the American Institute of Physics building. *The Acoustical Society of America provides a forum of* high scientific expertise and credibility for the writing and production of acoustical standards. This forum has served well the standards writing activities in the United States and internationally.

Standards News from the United States

The following news items have been received since the last issue of *Standards News*.

ANSI issues New Catalog

ANSI's 1984 *Catalog of American National Standards* will be issued this month. It lists some 8000 standards approved by the Institute. All are available from ANSI.

The standards deal with dimensions, ratings terminology and symbols, test methods, and performance and safety requirements for materials, equipment, components, and products ranging from abrasives to zippers.

The 168-page catalog gives users ready access to standards in a wide range of fields, including: acoustical; construction, electrical and electronics; heating, air-conditioning, and refrigeration; image technology; information systems; mechanical; measurement and automatic control; medical devices; nuclear; physical distribution, and safety and health.

The catalog contains two major sections—a listing of standards by subject and a compilation of the designations of all standards listed.

Copies are being mailed to Institute members, public libraries, and those who placed orders. Members and libraries that serve the general public receive the catalog and its supplements free. Nonmembers may obtain a copy from ANSI's Sales Department for $10.00.

New ANSI Standards Guide

A new guide just published by ANSI provides standards developers with detailed information on how to submit proposed standards to the Institute for public review and comment and for approval as American National Standards.

The 16-page booklet demystifies the BSR-8 and BSR-9 forms, which ANSI supplies to standards writing groups to facilitate submittals for comment and approval. Step-by-step instructions are provided on filling them out.

Information is also included on the action the ANSI staff takes when it receives the BSR-8 form, requesting listing in *Standards Action*. Advice is given on responding to people who commented during public review and on the action to take if substantive changes have been made in a draft to resolve objections.

The guide will be available to participants at the March 28 ANSI Seminar on Administering Domestic Standards Activities. Copies will also be mailed to all standards developing organizations after the seminar.

If you are interested in obtaining a single copy of the *Guide for Submitting Standards to ANSI for Approval*, send a self-addressed label to Dianne Kelley, secretary of the Board Standards Review, American National Standards Institute, 1430 Broadway, New York, NY 10018.

Individual copies of the guide will be provided at no charge.

 0001-4966/84/010331-02$00.80

NBS establishes new Laboratory Accreditation Program

NBS is establishing a new laboratory accreditation program (LAP) to accredit testing laboratories that provide pressure calibration services for devices in the pressure range of 130 micropascals to 280 megapascals. To implement the LAP under the procedures of the National Voluntary Laboratory Accreditation Program (NVLAP), NBS will hold a public workshop to establish the technical requirements for accreditation and the proficiency testing methods for assessing laboratory capabilities. The accuracy of pressure measurements is *important in nuclear power, aircraft operation, petroleum refining, food processing*, and other activities that depend on accurate and reliable pressure measurements. For information on the Pressure Calibration Services LAP or the public workshop that will be held at NBS on May 16, 1984, contact Manager, Laboratory Accreditation, B141 Technology Building, National Bureau of Standards, Washington, DC 20234, Tel. 301/921-3431.

NBS publishes new Standards Catalog

The Commerce Department's National Bureau of Standards (NBS) has published a new catalog which lists more than 900 standard reference materials (SRMs) that are available from NBS, as well as new ones that will be on the market.

For more than 75 years, NBS has provided SRMs to scientific, industrial, and commercial users throughout the United States and the world. These materials are used to help improve measurement accuracy by providing a way to calibrate instruments. This in turn helps companies to achieve quality assurance of materials and goods.

In the new catalog, SRM materials are listed in separate major groups, Chemical Composition Standards, Physical Property Standards, Engineering Type Standards, Research Materials, and Special Reference Materials. The catalog's format provides quick access to material description, certified characterization, unit size, and type. Order and shipping information are given in three languages. Prices for the materials are listed separately in annual supplements.

Copies of the new *NBS Standard Reference Materials Catalog, 1984–1985* (SP260), are available from the Office of Standard Reference Materials, B311 Chemistry Building, National Bureau of Standards, Washington, DC 20234, Tel.: 301/921-2045.

Committee E-33 of ASTM forms New Task Groups

A new task group on field tests on enclosures and a new task group on loudspeakers for open office tests were organized during the meetings of American Society for Testing and Materials (ASTM) Committee E-33 on Environmental Acoustics in Jacksonville, FL, April 9–11.

The task group on field tests on enclosures will develop a method to measure the sound isolation of installed enclosures, such as audiometric booths, translation booths, and other personnel enclosures.

The task group on loudspeakers for open office tests seeks to identify loudspeakers that satisfy the requirements of various tests that are performed in open plan spaces.

Subcommittee 2 on Open Plan Spaces held its first meeting in Jacksonville. The scope of the new Subcommittee is "the development of test methods and practices relating to materials, products, and systems used for the control of acoustics in open plan spaces, such as offices, schools, etc." The Subcommittee has set up five task groups to work on different aspects of open plan acoustics.

Two task groups of Subcommittee 2 are organizing round robin test series. The test series will provide information about the precision of proposed tests on office screens and ceiling systems.

Subcommittee 6 on International Standards is organizing the U.S. delegation to the plenary meeting of International Organization for Standardization, Technical Committee 43 Subcommittee 2 (ISO/TC43/SC 2) on Building Acoustics in West Berlin on October 31. The ASTM Subcommittee formulates U.S. positions on draft standards produced by the ISO Subcommittee.

The task group on ceiling suspension systems is polling manufacturers about problems with interfacing new grid systems and ceiling boards. The task group is also considering problems that occur when ceiling systems are used in special environments, where the atmosphere is humid or corrosive.

The next meetings of Committee E-33 will be in Norfolk, VA, 15–17 October 1984. For more information about E-33 activities contact David R. Bradley, ASTM Standards Development Division, 1916 Race Street, Philadelphia, PA 19103, Tel.: (215)299-5504.

Standards News from Abroad

The following news items have been received since the last issue of *Standard*. Vol. 1.

New ISO Statistical Report

An up-to-date profile of the International Organization for Standardization emerges from ISO in *Figures*, a statistical report issued by the Central Secretariat. Some highlights follow.

The ISO's membership consists of 89 national standards bodies – 74 member bodies and 15 correspondent members.

In 1983, ISO published 553 new and revised standards, bringing the total number of current standards to 5273. These standards were developed by 165 technical committees, 610 subcommittees, and 1391 working groups.

On average, ISO reports, nine meetings of these technical bodies are in progress somewhere in the world, each working day of the year.

Approximately 400 people are employed by the 34 member bodies who provide the administrative support for the technical secretariats. In Geneva, a staff of 136 persons from 21 countries coordinates the worldwide activities of ISO.

New IEC Standards for Audio–Visual Equipment

Of special interest to manufacturers, distributors, and users of audio-visual, video, and television systems and equipment are new world standards recently established by the International Electrotechnical Commission.

Two new publications in the IEC 574 series deal with connectors and striped cards, respectively.

IEC Publication 574-3: Connectors for the interconnection of equipment in audio–visual systems. This collation adds some new material and combines existing, agreed-upon standards in this area into one publication which covers four systems of interconnection. Concentric connectors for audio systems, Circular connectors for audio, audio-visual, and video systems, Circular connectors for audio systems, and Coaxial connectors for video systems.

IEC Publication 574-14: Audio striped card system. Audio striped cards have a strip of magnetic tape at the lower part of one side. Information can be recorded on one track of the tape by a teacher and, when a card is placed in a specially designed card reader, the recording is played back to the student or trainee. While the card is in the reader, most of its surface is still visible and may contain a picture or words appropriate to the recorded information. A second track on the tape can be used by a student or trainee for making an appropriate recording in response to instructions given.

IEC/SC50A meets in Italy

A meeting of the IEC/SC 50A International Committee was held in Milan, Italy, May 4 and 5, 1984. The United States delegates to the meeting were Glenn Carter, U.S. SC 50A Technical Advisor and E. Eric Heberlein, Secretary of SC 50A working Group 8 on Seismic, Sine Beat, and Time-history tests.

Standards approved and published by ANSI

The following standards were approved and published by ASA:

ANSI S1.4–1983	"American National Standard Specification for Sound Level Meters"
ANSI S2.20–1983	"American National Standard Estimating Airblast Characteristics for Single Point Explosions in Air, with a Guide to Evolution of Atmospheric Propagation and Effects"
ANSI S3.29–1983	"Guide to the Evaluation of Human Exposure to Vibration in Buildings"
ANSI S12.1–1983	"American National Standard Guidelines for the Preparation of Standard Procedures to Determine the Noise Emission from Sources"
ANSI S2.58–1983	"American National Standard Auxiliary Tables for Vibration Generators: Methods of Describing Equipment Characteristics"
ANSI S2.45–1983	"American National Standard Electrodynamic Test

Equipment for Generating Vibration—Methods of Describing Equipment Characteristics"

The above standards are available from the Standards Secretariat at the following address: AIP Publication Sales, Dept. STD, 335 East 45th Street, New York, NY 10017. (A 20% discount is available to individual and sustaining members of the Society.)

International documents on acoustics received in the United States

The documents listed below have been received by the Standards Secretariat of the Society and have been announced to S1, S2, S3, or S12. The document number is listed to the left of each document and the Accredited Standards Committee to which the document was announced is listed in parentheses below the document number. Further information on each document can be obtained from the Standards Secretariat.

The following documents have been received from ISO for vote:

ISO/DIS 2953 (S2)	Balancing machines—Description and evaluation
ISO DIS 7919/1 (S2)	Mechanical vibration of nonreciprocating machines—Measurements on rotating shafts and evaluations—part 1. General guidelines

Standards from Other Standards Organizations

The following documents have been received from ASHRAE and CAGI for comment:

S5.1-198X (S12)	Test Code for the Measurement of Sound from Pneumatic Equipment.
ASHRAE Standard-68-78R (S12)	Method of Testing In-Duct Sound Power Measurement Procedure for Fans.

Report on (ISO/TC/43 Acoustics, ISO/TC43/SC1 Noise, ISO/TC/108 Mechanical Vibration and Shock, IEC/SC50A Shock and Vibration Tests, and IEC/TC29 Electroacoustics

The following information about the activities of International Standards and documents processed by Standards Secretariat of ASA is provided below:

ISO/TC43 Acoustics and ISO/TC43 SC1 Noise

The following documents were received for vote by the U.S. Member Body:

- ISO/DIS 3747—Determination of sound power levels of noise sources—Survey method using a reference sound source.
- ISO/DIS 3748—Determination of sound power levels of noise sources—Engineering method for small, nearly omnidirectional, sources under free-field conditions over a reflecting plane.

Announced to S12 on 15 August 1983. The U.S. position on ISO/DIS 3747 (to accept with editorial corrections) was submitted to ANSI on 31 January 1984. The U.S. position on ISO/DIS 3748 is to be submitted shortly.

- ISO/DIS 1996/2—Description and measurement of environmental noise; Acquisition of data pertinent to land use
- ISO/DIS 1996/3—Description and measurement of environmental noise; application to noise limits

Announced to S12 on 15 August 1983. The U.S. position on ISO/DIS 1996/2 (negative with comments) was submitted to ANSI on 4 January 1984. The U.S. position on ISO/DIS 1996/3 (to abstain with comments) was submitted to ANSI on 5 March 1984.

- ISO/DIS 6081.2—Acoustics—Noise emitted by machinery and equipment—Guidelines for the preparation of test codes of engineering grade requiring noise measurements at the operator's position.

Announced to S12 on January 1984. The U.S. submitted an affirmative note with comments on 13 March 1984.

ISO/TC 108 Mechanical Vibration and Shock (and Subcommittees SC1, SC2, SC3, and SC4

The following document was received for vote by the U.S. Member Body:

- ISO/DIS 2953 Balancing machines—Description and evaluation

Announced to S2 (TAG for ISO/TC 108) on 5 March 1984. Mr. Stadelbauer is coordinating the U.S. response.

The following documents were received for comment by the U.S. Member Body:

- ISO/TC 108 Third Draft Proposal, *ISO DP 7626/2*, Methods for the Experimental Determination of Mechanical Mobility, Part 2, Measurements using single-point translation excitation *with an attached vibration exciter (ISO TC 108/N 379) (Prepared by TC 108/WG 14.)*

Announced to S2 (TAG for TC 108) on 13 February 1984. Mr. Baade is coordinating the U.S. response.

- ISO/TC 108 First Draft Proposal Vibration and Shock—Shock Testing Machines—Characteristics and Performance. (ISO/DP 8568) (Prepared by TC 108/WG 15.)

Announced to S2 on 13 February 1984. Mr. Tillou is coordinating the U.S. response.

- ISO/DP 8569 ISO/TC 108 N374 First Draft Proposal—for Vibration-sensitive equipment—guide for methods of measurement and evaluation of vibration effects. (Prepared by TC 108/WG 16.)

Announced to S2 on 13 February 1984. The comments are being coordinated by Mr. Frey.

IEC/TC 29 Electroacoustics, IEC/SC 29C Measuring Devices and IEC/SC 29D Ultrasonics

The following documents were received for vote under the six months' rule by the U.S. Member Body:

- SC29C (Central Office) 57—Sound Calibrators.

Announced to S1 on 27 January 1984. Mr. Seiler is preparing the U.S. response which will be submitted shortly.

- SC29C (Central Office) 56—Aural Impedance/Admittance Instruments.

Announced to S3 on 27 January 1984. The U.S. position (negative with comments) was submitted to ANSI on 15 March 1984.

The following document was received for comment by the U.S. Member Body:

- Draft—IEC ISC29D Publication for filters for the measurement of audible noise emitted by ultrasonic equipment 29 (Secretariat) 169.

Announced to S1 and S3 on 21 November 1983. The U.S. comments were submitted to ANSI on 9 January 1984 together with a negative position.

IEC/SC50A Shock and Vibration Tests

The following documents were received for comment by the U.S. Member Body:

- IEC SC50A (Secretariat) 199 Draft—Basic Environmental Testing Procedures—Test Fg: Acoustic vibration test.

Announced to S2 on 15 December 1983. The U.S. comments were submitted to the Technical Advisor on 6 February 1984.

- IEC SC50A (Secretariat) 200: Draft—Basic Environmental Testing Procedures-Test f Vibration: Time-history method.
- IEC SC50A (Secretariat) 201: Draft—Basic Environmental Testing Procedures—Test Fe—Vibration: Sine-beat method.

Announced to S2 on 4 January 1984. Mr. Heberlein is coordinating the U.S. response.

SHORT COURSES

NOVEMBER

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates November 5-9, 1984
Place San Francisco, California
Dates December 3-7, 1984
Place Huntsville, Alabama
Dates February 4-8, 1985
Place Santa Barbara, California
Dates March 11-13, 1985
Place Washington, D.C.
Dates May 6-10, 1985
Place Boston, Massachusetts

Objective Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos Street, Santa Barbara, CA 93105 - (805) 682-7171.

RELIABILITY ENGINEERING AND MANAGEMENT

Dates: November 26-30, 1984
Place: Tucson, Arizona

Objective: Emphasis will be on system reliability prediction, reliability testing, mechanical reliability, burn-in testing, dormancy reliability, software reliability, life-cycle costing, design to cost, maintainability, availability, safety, liability, quality and their management.

Contact: The Office of Special Professional Education, College of Engineering, Harvill Bldg. No. 76, Box 9, The University of Arizona, Tucson, AZ 85721 -- (602) 626-3054.

MACHINERY VIBRATION ANALYSIS

Dates: November 27-30, 1984
Place: Lisle, Illinois

Objective: In this four-day course on practical machinery vibration analysis, savings in production losses and equipment costs through vibration analysis and correction will be stressed. Techniques will be reviewed along with examples and case histories to illustrate their use. Demonstrations of measurement and analysis equipment will be conducted during the course. The course will include lectures on test equipment selection and use, vibration measurement and analysis including the latest information on spectral analysis, balancing, alignment, isolation and damping. Plant predictive maintenance programs, monitoring equipment and programs, and equipment evaluation are topics included. Specific components and equipment covered in the lectures include gears, bearing (fluid film and antifriction), shafts, couplings, motors, turbines, engines, pumps, compressors, fluid drives, gearboxes, and slow-speed paper rolls.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

MACHINERY VIBRATION ENGINEERING

Dates: November 27-30, 1984
Place: Lisle, Illinois

Objective: Techniques for the solution of machinery vibration problems will be discussed. These techniques are based on the knowledge of the dynamics of machinery; vibration measurement, computation, and analysis; and machinery characteristics. The techniques will be illustrated with case histories involving field and design problems. Familiarity with the methods will be gained by participants in the workshops. The course will include lectures on natural frequency, resonance, and critical speed determination for rotating and reciprocating equipment using test and computational techniques; equip-

ment evaluation techniques including test equipment, vibration analysis of general equipment including bearings and gears using the time and frequency domains; vibratory forces in rotating and reciprocating equipment; torsional vibration measurement, analysis, and computation on systems involving engines, compressors, pumps, and motors; basic rotor dynamics including fluid film bearing characteristics, critical speeds, instabilities, and mass imbalance response; and vibration control including isolation and damping of equipment installation.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

DECEMBER

FIELD INSTRUMENTATION AND DIAGNOSTICS

Dates: December 3-6, 1984

Place: Houston, Texas

Objective: To provide a balanced introduction to diagnostic instrumentation and its applications for evaluating rotating machinery behavior. The seminar also covers fundamental rotating machinery behavior and some of the more common machinery malfunctions. It includes a lab session with workshops on data acquisition instrumentation, balancing, oil whirl/whip and rubs, and monitor system calibration.

Contact: Bob Grissom, Customer Training Department, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-9315.

MARCH

PENETRATION MECHANICS

Dates: March 18-22, 1985

Place: San Antonio, Texas

Objective: This course presents the fundamental principles of penetration mechanics and their application to various solution techniques in different impact regimes. Analytical, numerical, and experimental approaches to penetration and perforation problems will be covered. Major topic headings of the course are: fundamental relationships, material considerations, penetration of semi-infinite targets, perforation of thin targets, penetration/perforation of thick targets, hydrocode solution techniques, experimental techniques. Discussions will include such topics as fragment or projectile breakup, obliquity, yaw, shape effects, and richochet. Shock propagation, failure mechanisms and modeling, constitutive relations, and equation-of-state will be presented in the context of penetration mechanics. Developed fundamental relationships will be applied in the following areas: hypervelocity impact, long rod penetration, spaced and composite armors, explosive initiation, hydrodynamic ram, fragment containment, earth penetration, crater/hole size, spallation, shaped charge penetration.

Contact: Ms. Deborah J. Stowitts, Southwest Research Institute, 6220 Culebra Road, San Antonio, TX 78284 - (512) 684-5111, Ext. 2046.

VIBRATION CONTROL

Dates: March 26-29, 1985

Place: Washington, D.C.

Objective: This vibration control course will include all aspects of vibration control except alignment and balancing. (These topics are covered in separate Institute courses.) Specific topics include active and passive isolation, damping, tuning, reduction of excitation, dynamic absorbers, and auxiliary mass dampers. The general features of commercially available isolation and damping hardware will be summarized. Application of the finite element method to predicting the response of structures will be presented; such predictions are used to minimize structural vibrations during the engineering design process. Lumped mass-spring-damper modeling will be used to describe the translational vibration behavior of packages and machines. Measurement and analysis of vibration responses of machines and structures are included in the course. The course emphasizes the practical aspects of vibration control. Appropriate case histories will be presented for both isolation and damping.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

MAY

ROTOR DYNAMICS

Dates: May 6-10, 1985

Place: Syria, Virginia

Objective: The role of rotor/bearing technology in the design, development and diagnostics of industrial machinery will be elaborated.The fundamentals of rotor dynamics; fluid-film bearings; and measurement, analytical, and computational techniques will be presented. The computation and measurement of critical speeds vibration response, and stability of rotor/bearing systems will be discussed in detail. Finite elements and transfer matrix modeling will be related to computation on mainframe computers, minicomputers, and microprocessors. Modeling and computation of transient rotor behavior and nonlinear fluid-film bearing behavior will be described. Sessions will be devoted to flexible rotor balancing including turbogenerator rotors, bow behavior, squeeze-film dampers for turbomachinery, advanced concepts in troubleshooting and instrumentation, and case histories involving the power and petrochemical industries.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

DIAGNOSTICS - 85
September 16-20, 1985
Leszno, Poland

Applied Mechanics Institute, Technical University of Poznań and Machine Health Monitoring Group, Polish Academy of Sciences announce a School of Diagnostics with international participations. It will be held at Rydzyna Castle near Leszno on September 16-20, 1985 with main topic "Diagnostic Inference."

The languages of the School will be Polish and English. Preprinting of the proceedings is planned with 14 pages for an invited lecture and four pages for a contributed paper with one additional page of Polish summary for each paper.

Presently there are seven invited lectures giving the following program outline for the School:

- The Strategy of Distinctive Features Choice in Active Diagnostic Experiment -- J. Adamczyk, Mining Academy Cracov
- Classification Methods for Diagnostic Research -- W. Cholewa, Silesian T.U.
- Application of Artificial Intelligence to Diagnostic Inference Problems -- R. Tadeusiewicz, Mining Academy Cracov
- Discriminant Analysis of Multidimensional Stochastic Processes in Application to Diagnostics -- M. Krzysko, Poznań University
- Utility Performance Criterions for Technical Systems -- L. Bedkowski, Military Academy
- Prognostic Inference in Diagnostics of Machinery -- W. Batko, Mining Academy Cracov, and J. Kaźmierczak, Silesian T.U.
- Diagnostic Filtration of Machinery Vibroacoustical Signals -- C. Cempel, T.U. Poznań

For further information contact: Prof. C. Cempel, Technical University of Poznań, Piotrowo 3, P.O. Box 5, 60-965 Poznań, Poland.

CALL FOR PAPERS

INTERNATIONAL CONFERENCE ON ROTORDYNAMICS
September 14-17, 1986
Tokyo, Japan

The conference is sponsored by: International Federation for Theory of Machines and Mechanisms (IFToMM) and Japan Society of Mechanical Engineers; and co-sponsored by: American Society of Mechanical Engineers, Institution of Mechanical Engineers, Verein Deutscher Ingenieure, Japan Society of Precision Engineering, and Japan Society of Lubrication Engineers.

Papers on recent topics in the following areas of rotordynamics are invited: system identification, bearings, blade dynamics, seal dynamics, balancing, foundations and support dynamics, cracked rotors, trouble shooting, seismic and stochastic response, hydraulic machinery, couplings, diagnostic monitoring, measurements and processing of vibration data, torsional dynamics, component life estimation procedure.

Both theoretical papers and practical papers on field experiences and case histories are welcome. The official language at the conference will be English.

Prospective authors should submit abstracts of their papers in no less than 1,500 words with an adequate number of tables and figures by September 1, 1985. All abstracts must be in English and submitted in triplicate.

Authors will be notified by January 1, 1986 whether their papers are accepted or not. The authors of selected papers should submit camera-ready copies by May 1, 1986.

For further information contact: The Japan Society of Mechanical Engineers, Sanshin Hokusei Bldg., 4-9, Yoyogi 2-chome, Shibuya-ku, Tokyo, Japan, or The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

REVIEWS OF MEETINGS

NATIONAL CONFERENCE AND WORKSHOP ON TAILORING ENVIRONMENTAL STANDARDS TO CONTROL CONTRACT REQUIREMENTS

This conference was sponsored by the Institute of Environmental Sciences in cooperation with the Defense Materiel Standards and Specifications Office, and it was held in Leesburg, Virginia, 19-21 June 1984. The object of this conference was to acquaint program managers, designers and test engineers with the requirements for tailoring standards and specifications in the hardware acquisition process. The agenda for the first day of the conference included a plenary session with a keynote address followed by a series of invited high-level position papers on tailoring specifications and standards in the material acquisition process.

The keynote address was presented by Ms. Mary Ann Gilleece, Deputy under Secretary of Defense for Research and Engineering (Acquisition Management). She reviewed the progress of the implementation of the Material Acquisition Improvement Initiatives and she identified some of the initiatives that still needed attention. These initiatives included more stable program funding to permit multi-year contracting, more economical ordering quantities, more realistic cost estimates and promoting competition in the Defense material procurement process. She concluded the keynote address with her thoughts on the importance of the tailoring requirements in Initiative 14.

A series of invited papers on implementing tailoring of specifications and standards followed the keynote address. Viewpoints on the tailoring process were presented by representatives of the Department of Defense, the Army, the Navy, the Air Force, Industry, and the Institute of Environmental Sciences. Most of the invited speakers shared the same overall viewpoints on tailoring standards and specifications:

1. Tailor specifications and standards to reflect the desired end product performance requirements.
2. Product requirements must be tailored to ensure they are invoked at the most cost-effective level.
3. Eliminate irrelevant standards and specifications in contracts or requests for proposals.
4. Allow contractors a greater role in setting system performance requirements.
5. Avoid using specifications or standards that seek to impose premature solutions to problems.

Even though the invited speakers shared nearly the same overall perceptions of tailoring, they also had their own interests and individual approaches to implementing tailoring.

Dr. Richard Stimson, Director of Industrial Productivity, in the Office of the Undersecretary of Defense for Research and Engineering, spoke on tailoring contract requirements from the standpoint of improving the level of industrial productivity. He felt it was essential to modernize the United States industrial base to improve our industrial productivity, and he felt it was just as important to maintain a high level of quality in our manufactured products. Dr. Stimson linked the tailoring requirements in Acquisition Improvement Initiative 14 to continued product quality assurance, and to improvement in the level of United States industrial productivity.

Mr. Edmond Westcott, Assistant for Product Assurance in the Air Force Systems Command, described some of the steps the Air Force has taken to improve product quality and to help implement the tailoring of contractual requirements. Examples of steps taken to improve product quality were the imposition of combined environment reliability test requirements and environmental stress screening requirements in system procurements. Future plans call for the circulation of draft requests for proposals to industry for comment and the use of a computer-aided acquisition documents system to select or tailor the appropriate clauses to be included in product specifications.

Mr. Brent Hardesty, representing the Council of Defense and Space Industry Associations, presented

industry's view of the tailoring process. He discussed the trend toward the growth in the amount of detail in specifications, the growth in the size of specifications and the growth in the number of specifications that are invoked in product procurements. He presented examples of procurement actions to illustrate the growths in the size, number and the amount of detail in product specifications.

Mr. Seymour Lorber, Director, Product Assurance and Test, U.S. Army Material Development and Readiness Command, presented the Army's position on implementing tailoring of contract requirements. Mr. Lorber pointed out that one of the most important tasks in establishing system requirements is to define the environments in which a system will operate early in the development program, to effectively tailor its design and test requirements. He also feels that system requirements should be tailored to use readily available, or "off-the-shelf" products to the maximum extent possible consistent with system needs. The Army is using this concept to purchase trucks, and they plan to extend it to the procurement of communications equipment. Tailoring system requirements to "off-the-shelf" material is advantageous because it saves development costs and it saves time in fielding a system.

Mr. Willis Willoughby, Deputy Chief of Naval Material, presented the Navy's perspectives on tailoring. He encouraged tailoring equipment contract requirements to use a manufacturer's "best practices' in lieu of procuring material in accordance with military specifications. One advantage of tailoring material contract requirements to a manufacturer's "best practices" is that it may be possible to buy "off-the-shelf" material which will meet a system's performance requirements, at considerable savings in money and in the time it takes to field a new system.

Bob Hancock, Director of the Institute of Environmental Sciences Product Reliability Division, presented the Institute's position on tailoring contract requirements from the standpoints of environmental engineering and tailoring test requirements. He described a typical system's life cycle and the different types of environmental tests, e.g., development, qualification, acceptance or reliability tests, that might be performed in different phases of an equipment's life cycle. He stressed the importance of performing the environmental engineering studies, and the test tailoring process, early in a system development program to maximize the influence on the system's life-cycle costs.

Kurt Greene, Director, Technology Division, Defense Materiel Specifications and Standards Office, presented an overview of some of their initiatives to provide the training and the guidelines for tailoring contract requirements. These included a recent workshop to acquaint program managers with tailoring contract requirements in material acquisition programs, and the preparation of DOD Handbook 248B to provide guidance for tailoring specifications and standards.

Following the plenary session, the conference was divided into four working groups to discuss tailoring issues related to management and planning, design and analysis, test and verification and education and training. The findings of each of the working groups were reported in a plenary session on the last day of the conference. Interestingly, many of the working groups independently identified the following issues, surrounding the tailoring of environmental specifications and standards, which should be resolved:

1. The availability of environmental data.
2. The risk of being non-compliant, or of losing out on a contract, because environmental test requirements were tailored, must be minimized.
3. The relationship between safety margins and tailoring test requirements.
4. Who tailors the test requirements, and what resources are available to ensure the tailoring is done properly?

R.H.V.

ABSTRACTS FROM THE CURRENT LITERATURE

ABSTRACT CONTENTS

AVAILABILITY OF PUBLICATIONS ABSTRACTED

None of the publications are available at SVIC or at the Vibration Institute, except those generated by either organization.

Periodical articles, society papers, and papers presented at conferences may be obtained at the Engineering Societies Library, 345 East 47th Street, New York, NY 10017; or Library of Congress, Washington, D.C., when not available in local or company libraries.

Government reports may be purchased from National Technical Information Service, Springfield, VA 22161. They are identified at the end of bibliographic citation by an NTIS order number with prefixes such as AD, N, NTIS, PB, DE, NUREG, DOE, and ERATL.

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U.S. patents and patent applications may be ordered by patent or patent application number from Commissioner of Patents, Washington, D.C. 20231.

Chinese publications, identified by a CSTA order number, are available in Chinese or English translation from International Information Service, Ltd., P.O. Box 24683, ABD Post Office, Hong Kong.

When ordering, the pertinent order number should always be included, not the DIGEST abstract number.

A List of Periodicals Scanned is published in issues, 1, 6, and 12.

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 2150, 2151, 2222, 2237, 2306, 2312, 2332, 2334, 2339)

84-2120

The Effect of Stationary Rotation on the Position of Mass Centres of Rotating Deforming Mechanical Systems

A.P. Kavolėlis and V. Turla

Vilnius Civil Engrg. Inst., Vilnius, Lithuanian SSR, Dynamics and Strength of Machinery and Structures, 25th Proc. in Mechanics, Vilnius Civil Engrg. Inst., Lithuanian SSR, 1981, pp 97-103, 3 figs, 3 refs (In Russian)

Key Words: Rotating structures, Rotational response

A certain class of mechanic systems (solid bodies), which can deform due to the relative shift in the kinematic pair, is investigated. It is shown that the deformations of systems due to rotation decrease the distance between the axis of rotation and the center of mass. It is also shown that in any rotating system, the rotation causes a certain mass redislocation and reduces the static moment of the axis of rotation.

84-2121

Vibratory Problems on Gas Turbine Rotors

G. Sacchi and B. Moro

FIAT T.T.G., Turin, Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 7-15, 10 figs, 4 refs

Key Words: Rotors, Gas turbine engines, Vibration analysis, Stability

The paper deals with the presentation of rotor vibratory problems and their solution. Following a brief mention of rotor assembly and balancing procedures, the main topic covers the type of vibrations related to oil whip, internal friction whirl, organ pipe resonance, radial rubbing, cold transient vibration and dynamic behavior of a rotor in cases of improper turning gear operation. Each of the above mentioned problems is presented in terms of rotor vibratory behavior shown with vibration records in the time and/or frequency domain.

84-2122

Investigations into Output Dependent Rotordynamic Instability of the High Pressure Rotor on a Large Turbo-Generator

S.H. Greathead and M.D. Slocombe

Scientific Services Dept., Central Electricity Generating Board, N.E. Region, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 27-35, 9 figs, 17 refs

Key Words: Turbogenerators, Stability, Fluid-induced excitation

This paper describes some of the investigational work conducted on one type of large turbo-generator to understand the rotordynamic instability of the high pressure rotor experienced at high MW outputs on some machines. In addition to measurements on operational machines, the paper presents some results from a gland rig which has been built to determine forces generated in multi-fin shaft labyrinth glands under dynamic conditions -- with the shaft both rotating and precessing. From analysis of the operational measurements and gland rig results, it shows that the output dependence of the rotor instability arises from static and de-stabilizing steam forces generated inside the high pressure turbine and describes how these forces originate.

84-2123

Double Frequency Vibration in Large Turbo-Generator Rotors -- A Design Problem

W. Kellenberger and P. Rihak

Brown Boveri & Cie, Switzerland, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 37-47, 8 figs, 4 tables, 9 refs

Key Words: Rotors, Turbogenerators, Flexural vibration

In recent years it has been possible to study rotors having multiple bearings and variable difference of flexural rigidities. A method is presented which applies to a shaft line having

several bearings, with internal and external damping. The difference between the flexural rigidities may vary along the length of the line, and the directions of the largest and smallest flexural rigidities may also be interchanged along the length. This permits the designer not only to balance the active part but also to evaluate the changes in the double-frequency vibration caused by intrusions into the rotor, such as holes for lead-in studs or slots. A significant advantage of the method given is that it makes use of the vibration calculations which are routinely made for the design and analysis of the shaft line.

84-2124

Rotor-Support Parametric Instability Limits in Terms of Rotor Receptances in Rotating Axes

J.M. Krodkiewski and Z.A. Parszewski
Univ. of Melbourne, Parkville, Victoria 3052, Australia, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 55-65, 12 figs, 11 refs

Key Words: Rotors, Parametric vibration

The paper shows that the composed type of parametric vibrations of rotor-support systems can be expressed by *composition of harmonic* responses and introduces the rotor dynamic receptance (stiffness) matrices expressed in rotating coordinants, into the instability regions boundaries equations. This dramatically lowers the rotor matrices orders in the system infinite determinant, giving the boundary equations. At the same time allowance is also given for support dynamic anisotropy giving rise to unsymmetry of the stiffness (and damping) matrices of interconnecting elements, that may correspond to journal bearings. Computed results show important influence of the unsymmetry of stiffness matrices on the parametric instability regions.

84-2125

Parametric Resonance in a Gyroscopic Rotor Driven through Hooke's Joint Mechanisms

D.D. Ardayfio
Dept. of Mech. and Aero. Engrg., Univ. of Missouri-Rolla, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 67-70, 5 figs, 12 refs

Key Words: Rotors, Universal joints, Parametric resonance, Gyroscopic effects

A two degree-of-freedom rotor system driven through a Hooke's joint is studied. The speed variation caused by the Hooke's joint angularity introduces periodic coefficients into the equations of motion for angular rotational displacements. The rotor driven via the Hooke's joint transmission is modeled with gyroscopic effects. The equations of motion are solved by the perturbation-variation method. The analytical results predict the effect of the Hooke's joint angularity on the existence and bandwidth of the parametrically excited unstable speed ranges. Illustrative charts are presented to show the variation of the instability region with the gyroscopic factor and joint angularity parameter.

84-2126

Economic Solutions of Rotordynamics Problems

M. Balda
SKODA National Corp., Central Res. Inst., 31600 Plzen, Czechoslovakia, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 71-82, 5 figs, 2 tables, 32 refs

Key Words: Rotors, Flexible rotors, Elastic foundations, Eigenvalue problems, Statistical linearization, Quasilinearization technique, Balancing techniques, Algorithms

The paper deals with approximate solutions of rotordynamic problems by methods which are applicable even on small computers. Approximate solutions of a complex eigenvalue problem are presented for rotors, which are supported in elastic damped bearings with spatial constraints. Planar vibrational modes of pure elastically supported rotors are employed for the solution. A method of solution of forced vibrations of the same rotors based on application of matrix exponential is introduced. Two methods are presented for a solution of nonlinear vibrations.

84-2127

Sensitivity of the Eigenvalues of Rotors to Parameter Modifications

C.P. Fritzen
Univ. of Kaiserlautern, Fed. Rep. Germany, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 103-110, 10 figs, 1 table, 4 refs

Key Words: Rotors, Structural modification techniques, Eigenvalue problems, Parmaeter identification technique, Sensitivity analysis

The vibration behavior of linear rotor systems with nonconservative effects can be valuated by means of the system eigenvalues. If calculations of eigenvalues in the design stage predict unstable vibrations, corrective measures are required. In such cases it can be very useful to have simple formulas, expressing the sensitivity of the eigenvalues to parameter modifications. A method is presented to determine the influence of parameter changes to the eigenvalues. The calculation is very simple and can easily be made part of a standard eigenvalue calculation for nonconservative rotors. Applications are given for different rotor models.

84-2128

Potential of Transfer Function Control of Rotor Whip and Balance

J. Mahig

Mech. Engrg. Dept., Univ. of Florida, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 111-115, 3 figs, 10 refs

Key Words: Shafts, Rotors, Whirling, Active control

The prospect of possibly unexpected problems with nonsynchronous whirl in systems designed to have cantilevered rotating masses, such as in helicopter rotors with mast mounted antennas, has created interest in novel methods for controlling shaft whirl. This paper examines the usefulness of obtaining a transfer function for a controller which will actively rebalance the rotor and pedestal while it is in operation. This control problem is explored as an application of modern control theory and identification methods which would enable the designer to automatically derive an effective transfer function for such a controller.

84-2129

A Method for Evaluating the Sensitivity of a Turbo-Generator Shaft Line Vibrational Behaviour to Changes in Bearing Coefficients

I.W. Mayes and W.G.R. Davies

C.E.G.B. Midlands Region, UK, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 203-206, 8 figs, 2 refs

Key Words: Shafts, Turbogenerators, Random excitation, Bearings, Sensitivity analysis

An analysis is presented which enables the effect of changes in bearing coefficients on the response of a turbo-generator shaft line to be determined. The method is a probabilistic one in which the ensemble average of the response to random excitation is calculated and this average is used to assess the sensitivity to bearing/support property changes.

84-2130

Studies on Nonlinear Vibrations and the Stability of an Unbalanced Rotor with a Cavity Partially Filled with Viscous Fluid

U.A. Djoldasbekov, E.R. Rakhimov, and A. Sh. Rakhmatullaev

The Kazakh State Univ., Alma-Ata, U.S.S.R., Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 117-121, 4 refs

Key Words: Shafts, Rotors, Fluid-filled containers, Unbalanced mass response

When solving practical tasks of the dynamics of rotor systems with cavities filled with fluids, it is of paramount importance to reveal a mechanism of interaction between the rotor and the fluid during their motion. Problems of motion of rotatable solid bodies with cavities containing a liquid were theoretically and experimentally studied and critical velocities and zones of instability of motion were found. The dynamics of the system (a model of a shaft of a gas turbine cooled by viscous fluid) is investigated, taking into account the rotor disbalance and the nonlinearity of equations of fluid motion.

84-2131

Rotor Dynamics of Non-Symmetrical Rotor-Bearing-Frame Systems

H. Alberg

Alfa-Laval AB, S-14700 Tumba, Sweden, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 123-128, 2 figs, 5 refs

Key Words: Rotors, Unbalanced mass response

A linear rotor-bearing-frame system with anisotropic bearings and unsymmetrical rigid frame is studied. It is shown

that the response due to unbalance can be described with elliptical orbits of rotor and frame points. The elliptical orbit can be split up into two circular orbits: one forward and one backward rotational component. A simple and very rapid iterative procedure for calculating the eigenfrequencies and corresponding eigenmodes at a specified speed of revolution is developed.

84-2132

A Forced Vibration Method to Calculate the Oil Film Instability Threshold or Rotor-Foundation Systems

G. Diana and C. Marcantoni-Taddei

Dept. of Mechanics, Politecnico of Milan, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 207-214, 6 figs, 2 tables, 9 refs

Key Words: Shafts, Turbogenerators, Interaction: rotor-foundation, Forced vibration, Bearings, Damping coefficients, Stiffness coefficients

With reference to the oil film instability phenomenon, this paper illustrates a method enabling one to evaluate, by means of the response to an imposed exciting force, the overall stability of a rotor on several supports, by simultaneously keeping account of the stiffness and damping characteristics of all the bearings. The approximation of this method is discussed and its application to a real case is ultimately shown.

84-2133

The Size of Turbo-Generating Sets and Permissible Vibrations

A. Vucetič, M. Butkovič, I. Sktrič, and B. Orcič

Jugoturbina, Karlovac, Yugoslavia, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 347-354, 8 figs 20 refs

Key Words: Rotors, Bearings, Turbomachinery, Vibration analysis

A summary of problems concerning permissible levels of bearing and rotor vibrations, as well as the problems of correlation with permissible unbalance of rotors, is presented. Mathematically expressed statistical data of the bearing vibrations of turbo-sets are also given. Dependence between the turbo-set output and size, bearing height from a foundation, journal diameter, bearing clearance and their correlation with vibrations, are statistically expressed.

84-2134

Stability of a Rigid Rotor Supported by Externally Pressurized Gas Journal Bearings with a Circular Slot Restrictor

S. Yoshimoto and Y. Nakano

Faculty of Engrg., The Science Univ. of Tokyo, 1-3 Kagurazaka, Shinjuku-ku, Tokyo, Japan, Bull. JSME, 27 (225), pp 561-568 (Mar 1984) 7 figs, 5 refs

Key Words: Rotors, Rigid rotors, Journal bearings, Stability

The stability of a rigid rotor supported by externally pressurized gas journal bearings with a circular slot restrictor is theoretically determined by use of the small perturbation method with respect to whirling amplitude. In the theoretical analysis, influences of the inertia forces of the gas film on the dynamic properties of this kind of bearing are investigated and theoretical results are compared with experimental data.

84-2135

Seismic Response of Vertical Shaft Pump Including Interaction Between Shaft and Pipe

T. Shimogo, K. Yoshida, and [illegible] Kazo

Keio Univ., Japan, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 439-448, 29 figs, 2 tables, 6 refs

Key Words: Shafts, Pumps, Seismic response

The frequency responses of a vertical shaft pump under a horizontal seismic excitation were studied, and the rms responses were obtained assuming a stationary Gaussian colored noise input. An interaction between a water lifting pipe and a driving shaft was especially examined by a theoretical treatment based on experimental results of dynamic characteristics of water bearing.

84-2136

"Elastic Solution" for Vibration Trouble on Vertical Pumps

S.G. Marenco and L. Vergani

Worthington Nord S.p.A., Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy pp 429-437, 16 figs, 5 refs

Key Words: Pumps, Nuclear power plants, Vibration control, Stiffness coefficients

Vibration problems encountered during installation of a group of vertical pumps of a nuclear plant were dealt with and resolved. The work was considered from a theoretical as well as an experimental point of view. A calculation program was used to determine stiffness values assigned to supports to reduce both the frequencies and amplitudes of vibration.

84-2137

Vibration Problems on Large Rotating Machinery: Some Cases Experienced in ENEL Power Stations

M. Cadeddu, C. Frigeri, E. Gadda, and A. Clapis

ENEL, Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 469-478, 16 figs, 5 refs

Key Words: Rotating machinery, Power plants (facilities), Vibration analysis

Some cases of vibration problems which occurred on main and auxiliary machinery in thermoelectric power stations are described. These problems are particularly significant not only for the effects they had on the machinery itself, but also because of other factors such as the influence of the dynamic behavior of the supporting structure, the difficulties met in identifying the problems, and the peculiarity of the remedial solutions adopted.

84-2138

Analytical and Experimental Procedures for Rotordynamics Predictions During Development of New Turbomachines

E. Benvenuti and P. Lacitignola

Nuovo Pignone, Florence, Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 479-495, 17 figs, 2 refs

Key Words: Turbomachinery, Design techniques

When developing a newly designed, high-speed, high-power turbomachine it is often important to be able to reliably predict actual rotordynamic behavior, and to tune it accurately before proceeding with performance tests of the complete prototype. Procedures used for these purposes are outlined herein; the design of a new two-shaft gas turbine low-pressure spool is shown as an example. Rotordynamics prediction methods are matched with appropriate support testing on individual components and subassemblies to check predictions and gradually improve and update the analytical models.

84-2139

Theoretical and Experimental Investigations of Shaft Vibrations in Turbomachinery Excited by Cracks

B. Grabowski and O. Mahrenholtz

Institut f. Mechanik, Universität Hannover, Hannover, Fed. Rep. Germany, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 507-514, 19 figs, 14 refs

Key Words: Shafts, Rotors, Turbomachinery, Cracked media

In the past the dynamic behavior of rotors containing cracks has been studied mostly from a theoretical viewpoint. This paper deals with the comparison of analytical and experimental results of the dynamics of vibration of a rotor excited by means of an artificial crack. The experimental results are found to be in good agreement with those for the crack model used in the analysis. The general possibility of determining a crack by extended vibration control is indicated.

84-2140

On the Vibration Behaviour of a Cracked Rotor

L.R.K. Nilsson

Stal-Laval Turbin AB, Finspong, Sweden, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 515-524, 20 figs, 2 tables, 14 refs

Key Words: Shafts, Turbogenerators, Cracked media, Case histories

Vibration case histories are given for two occasions where large turbogenerator rotors (700 MW) were operated with propagating cracks. Vibration measurements were extensive, and nearly complete pictures of vibration changes have been obtained. Several examples from the measurement results are given mostly in the form of diagrams. A description of the measurement system and the monitoring strategy is also given.

84-2141

Vibration Phenomena in Boiler Feed Pumps Originating from Fluid Forces

R.D. Brown

Heriot-Watt Univ., Edinburgh, UK, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 497-506, 12 figs, 29 refs

Key Words: Pumps, Boilers, Fluid-induced excitation

The continuing development of boiler feed pumps has greatly increased operating speeds and power requirements. A survey of the available literature demonstrates that significant dynamic forces arise from bearings, seals and differential blade loading. Several examples are discussed where fluid force excitation resulted in high levels of vibration. Numerical estimates of these forces are readily available and have been incorporated into a general flexible rotor response program. The computer programs can be used to assess the effect of in-service modifications in addition to initial design calculations. These calculations can complement and amplify data available from vibration monitoring equipment, thus improving the reliability of feed pump operation.

84-2142

Vibrations and Critical Speed of Submersible Turbine Pumps

T. Chalko and K. Marynowski

Inst. of Applied Mechanics, Technical Univ. of Łódź, Poland, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 449-460, 14 figs, 9 refs

Key Words: Pumps, Turbines, Critical speeds

A method of determining vibrations and critical speeds of submersible turbine pumping assemblies mounted on a pipeline and submerged in a well is presented. The method was designed for effective engineering use, so operational computer memory and calculation time required are minimized.

84-2143

A Theoretical and Experimental Investigation on the Dynamic Behaviour of an Axial Pump

N. Bachschmid, B. Pizzigoni, A. Chessa, C. Guzzo, and A. Vallini

Politecnico of Milan, Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 461-467, 10 figs, 4 refs

Key Words: Pumps, Vibration source identification, Resonance

A few experimental and technical results relative to the behavior of a vertical axis axial flow pump in which high vibration levels were encountered, are shown. These vibrations have a prevalent harmonic component with a frequency of 20 Hz (4 per revolution with respect to the rotation frequency). This research is aimed at the determination of the vibration sources and also at the elimination of a resonance condition of the electric motor on which the vibration levels had reached unacceptable values.

RECIPROCATING MACHINES

(See No. 2330)

METAL WORKING AND FORMING

84-2144

The Selection of Optimal Stable Geometrical Configuration in Centerless Grinding

A.Y. Chien

Qinghai Agriculture and Animal Husbandry Machinery Factory, Xinin, Qinghai, People's Rep. China, Intl. J. Mach. Tool Des. Res., 24 (2), pp 87-93 (1984) 6 figs, 2 tables, 8 refs

Key Words: Machine tools, Grinding

This paper is a development of the rounding off theory of centerless grinding. Listed are some spectra of amplitude versus frequency of centerless ground surfaces under different stability configurations of a grinder. A method is presented for selecting the optimal stable geometrical configuration in centerless grinding.

84-2145

The Effect of Continuous Dressing on the Occurrence of Chatter in Cylindrical Grinding

T.R.A. Pearce

Univ. of Bristol, Bristol, UK, Intl. J. Mach. Tool Des. Res., 24 (2), pp 77-86 (1984) 4 figs, 10 refs

Key Words: Machine tools, Chatter

The technique of dressing a grinding wheel with a diamond roller at the same time as it is grinding, known as continuous dressing, can in certain cases be beneficial in terms of increased stock removal rate. In its application to the cylindrical grinding process, test work has shown that chatter can be a problem. A theoretical analysis has been performed to assess the effects of continuous dressing on stability with particular reference to dresser position, wheel speed and workpiece regeneration. The results show that in many cases the stability limit is reduced by the introduction of continuous dressing, so that due attention must be paid to the machine dynamic stiffness when using this process.

84-2146

Theory of Finite Amplitude Machine Tool Instability

H.M. Shi and S.A. Tobias

Univ. of Science and Technology, Wuhan, Hubei, People's Rep. China, Intl. J. Mach. Tool Des. Res., 24 (1), pp 45-69 (1984) 18 figs, 10 refs

Key Words: Machine tools, Chatter

A nonlinear theory of machine tool chatter is presented. It is shown that even when the machine tool structure is linear or only slightly nonlinear, large nonlinearity is introduced by two causes. First, by the chatter amplitudes exceeding a certain value, dependent on the mean chip thickness and the vibrating tool leaving the workpiece. Secondly, by a nonlinearity of the cutting force characteristics. Theoretical work is supported by experiments.

84-2147

The Effects of Chucking Condition on the Chatter Vibration

M. Doi, M. Masuko, and Y. Ito

Musashi Inst. of Tech., 1-28-1, Tamatsutsumi, Setagaya-ku, Tokyo, Japan, Bull. JSME, 27 (225), pp 540-544 (Mar 1984) 10 figs, 1 table, 5 refs

Key Words: Chatter, Machining

The effects of the type of chuck and chucking conditions on the stability threshold and on the chatter mark in turning are investigated experimentally. The stability limit of chatter vibration represented by the critical overhang length is in good agreement with the results of excitation tests on the chuck-workpiece system. The damping ability of the chuck-workpiece system has a large effect on the chatter mark; the magnitude of the chatter mark decreases with an increasing damping of the system.

STRUCTURAL SYSTEMS

BUILDINGS

(Also see No. 2369)

84-2148

Structural Identification of JPL Building 180 Using Optimally Synchronized Earthquake Records

G.H. McVerry and J.L. Beck

Earthquake Engrg. Res. Lab., California Inst. of Tech., Pasadena, CA, Rept. No. ERRL-83-01, 92 pp (Aug 1983)

PB84-162833

Key Words: Buildings, System identification techniques, Seismic response

Linear models of JPL Building 180 were identified from its strong-motion records obtained in the 1971 San Fern-

ando earthquake using two system identification techniques, both of which revealed a previously undetected time-shift of about 0.08 second between the digitized basement and roof records. Optimal alignment of the records produced improved matches between the measured and model responses, and overcame difficulties encountered in extracting physically reasonable estimates for the parameters of the third and higher modes from the original records.

84-2149

Analytical Models for the Dynamics of Buildings

S K Jain

Earthquake Engrg. Res. Lab., California Inst. of Tech., Pasadena, CA, Rept. No. EERL-83-02, 215 pp (1983)

PB84-161009

Key Words: Buildings, Floors, Seismic analysis

This thesis investigates the significance of in-plane floor flexibility on the dynamics of buildings, and develops analytical models for structures that have flexible floor diaphragms. Experience with past earthquakes demonstrates that this feature is particularly important for long, narrow buildings and buildings with stiff end walls.

TOWERS

(See No. 2160)

FOUNDATIONS

84-2150

Dynamic Interacting Response of Large Turbine-Generators Supported on Foundations of Different Flexibilities

I.A. Aneja

Steam Turbine Generator Div., Westinghouse Electric Corp., Lester, PA, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 129-138, 8 figs, 1 table, 1 ref

Key Words: Foundations, Rotors, Turbogenerators, Interaction: rotor-foundation

The effects of foundation flexibilities on the dynamic response of the tandem coupled rotor-bearing system of large turbine-generator units are described. The interactions between the turbine-generators and foundations are discussed. The total system model consisting of tandem coupled rotor-bearings, low pressure turbine cylinders, generator frame and various foundations was developed using a large general purpose finite-element computer program.

84-2151

Fan/Foundation Interaction -- A Computerized Solution

H. Ming Chen, V. Sgroi, and S.B. Malanoski

Mechanical Technology Inc., Latham, NY, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 139-149, 14 figs, 4 refs

Key Words: Foundations, Fans, Interaction: rotor-foundation, Computer-aided techniques

A comprehensive computer-based analysis to address fan/foundation interaction and dynamics systems has been developed. Emphasis is placed on ease of use, graphics capability, and multiple functions. The main features are the ability to calculate, totally or separately, the damped system natural frequencies and responses due to rotor imbalances, the undamped rotor critical speeds, and the foundation natural frequencies. An example fan/foundation dynamics problem with solution illustrates the main features of the computer code.

84-2152

Dynamic Analysis of a 660 MW Turbogenerator Foundation

N. Bachschmid, R. Bernante, and C. Frigeri

Politecnico of Milan, Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 151-161, 14 figs, 6 refs

Key Words: Foundations, Reinforced concrete, Turbogenerators

The foundation of a 660 MW turbogenerator, a reinforced concrete framework embedded on roughly 400 long piles

driven in the sandy soil of the site, has been extensively tested by means of inertial shakers. Test procedures and test equipments are described in detail and some experimental results are given.

84-2153

A Parametric Analysis for Vibrating Machine Foundations

G.C. Beolchini

Istituto di Scienza delle costruzioni, Univ. of L'Aquila, Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 191-201, 13 figs, 20 refs

Key Words: Foundations, Machine foundations, Lumped parameter method, Vibration analysis

Using a lumped parameter system to predict the behavior of a dynamically loaded rigid foundation, an effective and economical design is obtained. Many numerical analyses were performed to arrive at a satisfactory and reliable estimate for dynamic motions. A parametric analysis is also presented.

ROADS AND TRACKS

84-2154

Aircraft-Pavement Interaction in Runway Analysis

K. Vajarasathira, M. Yener, and E.C. Ting

Purdue Univ., West Lafayette, IN, ASCE J. Struc. Engrg., 110 (5), pp 1008-1020 (May 1984) 12 figs, 12 refs

Key Words: Interaction: wheel-pavement, Runways, Viscoelastic foundations, Moving loads

A dynamic analysis of stresses and deflections induced by moving vehicles and by linear temperature variations in airport pavements which lie on viscoelastic foundations is presented. A direct numerical method derived from the structural impedance approach is used. The method is sufficiently general to include the complete kinematic relationships that describe the interactions between traveling vehicles and the supporting structures.

POWER PLANTS

(Also see Nos. 2365, 2366)

84-2155

Tests of Spinning Turbine Fragment Impact on Casing Models

J.S. Wilbeck

Southwest Res. Inst., 6220 Culebra Rd., San Antonio, TX 78284, Nucl. Engrg. Des., 77 (3), pp 321-329 (Feb 1984) 12 figs, 2 tables, 5 refs

Key Words: Nuclear power plants, Impact response, Turbine components, Experimental data

Ten 1/11-scale model turbine missile impact tests were conducted at a Naval spin chamber test facility to assess turbine missile effects in nuclear plant design. The objective of the tests was to determine the effects of missile spin, blade crush, and target edge conditions on the impact of turbine disk fragments on the steel casing. The results were intended for use in making realistic estimates for the initial conditions of fragments that might escape the casing in the event of a disk burst in a nuclear plant.

84-2156

Probabilistic Methodology for Turbine Missile Risk Analysis

L.A. Twisdale, W.L. Dunn, and R.A. Frank

Research Triangle Inst., P.O. Box 12194, Research Triangle Park, NC 27709, Nucl. Engrg. Des., 77 (3), pp 343-356 (Feb 1984) 1 fig, 4 tables, 14 refs

Key Words: Nuclear power plants, Impact response, Turbine components, Computer programs

A methodology has been developed for estimation of the probabilities of turbine-generated missile damage to nuclear power plant structures and systems. Mathematical models of the missile generation, transport, and impact events have been developed and sequenced to form an integrated turbine missile simulation methodology. Probabilistic Monte Carlo techniques are used to estimate the plant impact and damage probabilities. The methodology has been coded in the TURMIS computer code to facilitate numerical analysis and plant-specific turbine missile probability assessments.

84-2157

Model Tests of Turbine Missile Impact on Reinforced Concrete

C.M. Romander and G.E. Sliter

Poulter Lab., SRI International, Menlo Park, CA 94025, Nucl. Engrg. Des., 77 (3), pp 331-342 (Feb 1984) 11 figs, 3 tables, 10 refs

Key Words: Nuclear power plants, Reinforced concrete, Impact response, Computer programs

The results of 25 impact tests on 1/11-scale models of reinforced concrete nuclear plant walls are presented. These tests determined experimentally the maximum velocity at which postulated turbine missiles are contained by typical reinforced concrete walls. The parameters varied were missile weight, velocity, orientation, and impact angle, as well as target design and thickness. The results showed that the NDRC perforation formula used extensively in current practice is overly conservative, whereas a newer empirical formula (CEA-EDF) gave reasonably conservative predictions of the test results.

84-2158

Probability Problems in Seismic Risk Analysis and Load Combinations for Nuclear Power Plants

L.L. George

Lawrence Livermore National Lab., CA, Rept. No. UCRL-86245-Rev.1, CONF-830889-1-Rev. 1, 10 pp (1983)

DE84004408

Key Words: Nuclear power plants, Seismic analysis, Probability theory

Seismic risk, load combination, and probabilistic risk problems in power plant reliability are described and applications of extreme value theory are suggested. Seismic risk analysis computes the probability of power plant failure in an earthquake and the resulting risk. Components fail if their peak responses to an earthquake exceed their strengths.

84-2159

Study of Parameters Important to Soil-Structure Interaction in Seismic Analyses of Nuclear Power Plants

T.A. Nelson

Lawrence Livermore National Lab., CA, Rept. No. UCID-19958, 218 pp (Dec 1983)

DE84005061

Key Words: Nuclear power plants, Seismic analysis, Interaction: soil-structure

The development of state-of-the-art techniques for analyzing the effects of soil-structure interaction on structures during earthquakes is outlined. Emphasis is placed on methods to account for energy dissipation as a result of both wave propagation away from the structure's foundation and hysteretic soil response. Solution techniques are grouped into two major types: substructure methods, which break the problem into a series of steps, and direct methods, which analyze the soil-structure model in one step.

OFF-SHORE STRUCTURES

84-2160

Design of Guyed Tower for 1,000 Ft. of Water

M.S. Glasscock and L.D. Finn

Exxon Co., U.S.A., P.O. Box 2189, Houston, TX 77001, ASCE J. Struc. Engrg., 110 (5), pp 1083-1098 (May 1984) 7 figs, 8 refs

Key Words: Guyed structures, Towers, Off-shore structures, Drilling platforms, Design techniques, Fatigue life, Fluid-induced excitation

The guyed tower is a new structural system that is technically feasible and economically competitive in the development of deepwater petroleum reserves. The installation of Exxon's Lena guyed tower in 1,000 ft of water has culminated 12 years of guyed tower technology development. The platform design is reviewed with emphasis on features unique to a guyed tower. Structural design, buoyancy tank design, guyed system design, pile foundation design, transportation and launch design, and pipeline riser design are covered. Severe storm analysis and fatigue analysis for the tower are also covered.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 2273, 2327)

84-2161

Elastic System Moving on an Elastically Supported Beam

T.C. Huang and V.N. Shah

Univ. of Wisconsin, Madison, WI, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 292-297 (Apr 1984) 5 figs, 19 refs

Key Words: Moving loads, Ground vehicles

The problem of a two-dimensional elastic system moving on a beam is considered. The moving elastic system or vehicle is represented by the structural members with distributed stiffness, damping, and inertia properties, and it is supported by the suspension units. The deformations of the moving system and the beam are represented by their corresponding eigenfunction series. The resulting governing equations are represented by the coupled, ordinary differential equations with variable coefficients. The equations of motion for an elastic platform moving with constant velocity on a beam are derived and solved by the Hamming's predictor-corrector method. Numerical examples are presented.

84-2162

A Coupled Structural-Acoustic Finite Element Model for Vehicle Interior Noise Analysis

S.H. Sung and D.J. Nefske

General Motors Res. Labs., Warren, MI 48090, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 314-318 (Apr 1984) 6 figs, 1 table, 16 refs

Key Words: Automobiles, Ground vehicle noise, Interior noise, Finite element technique

An analytical method is developed for predicting vehicle interior noise and identifying noise sources. The finite element models representing the vehicle structure and its enclosed acoustic cavity are coupled mathematically. A modal formulation is employed for solving the interior acoustic response, and an analysis is developed to identify the structural and acoustic modal participation as well as the boundary panel participation in producing the response.

84-2163

TRAXION: A Model for Predicting Dynamic Track Loads in Military Vehicles

A.G. Galaitsis

Bolt Beranek and Newman Inc., Cambridge, MA 02238, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 286-291 (Apr 1984) 9 figs

Key Words: Computer programs, Military vehicles, Tracked vehicles, Mathematical models

A method is outlined that can be used to predict the dynamic track loads and suspension loads that occur in high-speed track vehicles. The presentation includes a description of the mechanical model that was synthesized and a comparison of the predicted and measured dynamic track loads on an M113 armored personnel carrier.

84-2164

Identification of Vehicle and Collision Impact Parameters from Crash Tests

R. Brach

Univ. of Notre Dame, Notre Dame, IN 46556, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 263-269 (Apr 1984) 4 figs, 6 tables, 7 refs

Key Words: Collision research (automotive)

The classic theory of impact of rigid bodies to planar vehicle collisions has neglected the existence of a moment between impacting bodies. Inclusion of a moment and introduction of a moment coefficient of restitution allows the formulation of a planar collision model consisting of six algebraic equations relating the six initial velocity components of the two vehicles to their six final velocity components. The model contains collision geometry, vehicle geometry, vehicle inertial properties, and three coefficients. These coefficients are the classic coefficient of restitution, a friction coefficient, and the newly defined moment coefficient. This paper discusses the application of the theory of least squares to fit the experimentally determined velocity components to the six equations of the vehicle collision model.

84-2165

Control of Rapid Transit Propulsion System Noise

P.J. Remington and N.R. Dixon

Bolt Beranek and Newman, Inc., Cambridge, MA 02238, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 270-277 (Apr 1984) 11 figs, 5 refs

Key Words: Rail transportation, Noise generation, Noise reduction

An extensive series of diagnostic measurements was carried out on an urban rail propulsion system of the type that was found to have the greatest community noise impact. At high speed, the fan dominates all other sources by 10-15 dBA. At low speed, fan, gears, and drive motors make comparable noise. A series of tests on a laboratory model of the fan/end

housing of a propulsion motor showed that by modifying the geometry of the end housing posts and reducing the diameter of the cooling fan, the tone at the blade passage frequency was virtually eliminated. In addition, the overall noise was reduced by over 10 dBA while the same airflow was maintained through the fan.

84-2166

State-of-the-Art Review: Prediction and Control of Groundborne Noise and Vibration from Rail Transit Trains

J.T. Nelson and H.J. Saurenman

Wilson, Ihrig and Associates, Inc. Oakland, CA, Rept. No. UMTA-MA-06-0049-83-4, DOT-TSC-UMTA-83-3, 281 pp (Dec 1983)

PB84-158781

Key Words: Railroad trains, Sound propagation, Vibration analysis, Reviews

A comprehensive review of the state-of-the-art in the prediction and control of groundborne noise and vibration is provided. Various types of impact criteria are reviewed for groundborne noise and vibration, building damage, and soil settlement. Vibration measurement and evaluation techniques are reviewed and techniques which have been used by rail transit systems to control groundborne noise and vibration are discussed.

SHIPS

84-2167

On the High-Speed Porpoising Instability of a Prismatic Hull

P.R. Payne

Payne, Inc., Annapolis, MD, J. Ship Res., 28 (2), pp 77-87 (June 1984) 14 figs, 27 refs

Key Words: Ship hulls, Periodic excitation, Transient excitation, Stability

Simple closed-form solutions are obtained for the steady-state and transient forces and moments on a prismatic hull at speeds high enough for hydrostatic forces to be negligible and the chines to be above the undisturbed water surface. This solution can be transformed to obtain the correct results for other hydrodynamic problems, such as the vertical impact of a wedge, a slender foil, or the two-dimensional planing of a flat plate.

84-2168

Wave-Induced Hull Vibrations: An Experimental and Theoretical Study

A.W. Troesch

Univ. of Michigan, Ann Arbor, MI, J. Ship Res., 28 (2), pp 141-150 (June 1984) 16 figs, 25 refs

Key Words: Ship hulls, Ship vibration, Wave forces

The results of an experimental and theoretical study investigating the main hull girder vibrations of Great Lakes bulk carriers are presented. The source of the excitation is considered to be the incident waves. The emphasis of the work is to understand the hydrodynamic aspects of ship springing. Theoretical calculations based upon a short-wavelength assumption compare well with experiments.

84-2169

Vibration Force Reducer – and a New Approach to Ship Vibration

W. Ojak

Naval Architecture and Marine Engrg. Dept., Al Fateh Univ., Tripoli, Libya, J. Ship Res., 28 (2), pp 118-140 (June 1984) 44 figs, 4 tables, 5 refs

Key Words: Ship vibration, Vibration control, Vibration tuning

Excessive vibrations commonly occurring in modern ships are caused by hydrodynamic pressures due to a cavitating propeller. More than 20 years of practical experience with different ships investigated by the author have resulted in a novel approach to the problem of ship vibrations. A vibration force reducer (VFR) is described which can be installed on a ship and by a simple process of VFR tuning, the undesirable ship vibrations can be minimized for any given rpm.

AIRCRAFT

(Also see Nos. 2184, 2204)

84-2170

Strategies for and Validity of Noise Monitoring in the Vicinity of Civilian Airfields and Army Installations

P.D. Schomer, R.E. DeVor, and R.D. Neathammer

Construction Engrg. Res. Lab., (Army), Champaign, IL, Rept. No. CERL-TR-N-166, 53 pp (Jan 1984) AD-A137 780

Key Words: Aircraft noise, Airports, Noise measurement, Experimental data

It is common practice to use computer-generated noise contours or noise zone maps to assess noise impact and perform noise related land-use planning. However, developers and other interested parties often question the accuracy of computer simulations and suggest direct measurement to verify the computer predictions. This report quantifies the temporal sampling requirements for and the accuracy and ability of directly measured sampled data to estimate the true yearly day/night average sound level (DNL).

84-2171

Investigation of Fuselage Acoustic Treatment for a Twin-Engine Turboprop Aircraft in Flight and Laboratory Tests

J.S. Mixson, R.L. Oneal, and F.W. Grosveld
NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-85722, 37 pp (Jan 1984)
N84-16947

Key Words: Aircraft noise, Noise reduction, Interior noise

A flight and laboratory study of sidewall acoustic treatment for cabin noise control is described. In flight, cabin noise levels were measured at six locations with three treatment configurations. Noise levels from narrow-band analysis are reduced to one-third octave format and used to calculate insertion loss, IL, defined as the reduction of interior noise associated with the addition of a treatment. Laboratory tests used a specially constructed structural panel modeled after the propeller plane section of the aircraft sidewall, and acoustic treatments representing those used in flight.

84-2172

Noise of the SR-6 Propeller Model at 2 Deg and 4 Deg Angles of Attack

J.H. Dittmar and G.L. Stefko
NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. E-1864, NASA-TM-83515, 18 pp (Nov 1983)
N84-16946

Key Words: Aircraft noise, Interior noise

The noise generated by supersonic-tip speed propellers creates a cabin noise problem for future airplanes powered by these propellers. Noise of a number of propeller models were measured with flow parallel to the propeller axis. In flight, as a result of the induced upwash from the airplane wing, the propeller is at an angle of attack with respect to the incoming flow. Therefore, the 10-blade SR-6 propeller was operated at angle of attack to determine its noise behavior.

84-2173

Airloads Research Study. Volume 1: Flight Test Loads Acquisition

M.D. Bartlett, T.F. Feltz, A.D. Olsen, Jr., D.B. Smith, and P.F. Wildermuth
Rockwell International, Los Angeles, CA, Rept. No. NA-76-562, NASA-CR-170409, 125 pp (Jan 1984)
N84-17173

Key Words: Aircraft, Aerodynamic loads

The acquisition of B-1 aircraft flight loads data for use in subsequent tasks of the Airloads Research Study is described. The basic intent is to utilize data acquired during B-1 aircraft tests, analyze these data beyond the scope of Air Force Requirements, and prepare research reports that will add to the technology base for future large flexible aircraft. Flight test data obtained during the airloads survey program included condition-describing parameters, surface pressures, strain gage outputs, and loads derived from pressure and strain gauges. Descriptions of the instrumentation, data processing, and flight load survey program are included.

84-2174

Dynamics and Control of Forward Swept Wing Aircraft

D.K. Schmidt and T.A. Weisshaar
Purdue Univ., Lafayette, IN, Rept. No. NASA-CR-175369, 43 pp (Feb 10, 1983)
N84-17172

Key Words: Aircraft, Dynamic analysis

Aspects of non-zero differential game theory with application to multivariable control synthesis and optimal linear control law design using optimum parameter sensitivity analysis are discussed.

84-2175

Design of Helicopter Rotor Blades for Optimum Dynamic Characteristics

D.A. Peters, T. Ko, A. Korn, and M.P. Rossow

Washington Univ., St. Louis, MO, Rept. No. SASR-4, NASA-CR-175380, 29 pp (Jan 17, 1984)
N84-17171

Key Words: Propeller blades, Helicopters, Design techniques, Optimization

The optimal design of helicopter rotor blades is addressed. The forced response of an initial (nonoptimized) blade to those of a final (optimized) blade are compared. Response of starting design and optimal designs for varying forcing frequencies, blade response to harmonics of rotor speed, and derivation of mass and stiffness matrices or functions of natural frequencies are discussed.

84-2176

Army Helicopter Crashworthiness

C.H. Carper, L.T. Burrows and K.F. Smith
Army Res. and Tech. Labs., Fort Eustis, VA, Proc. of Conf. on Flight Mechanics and Syst. Design Lessons from Operational Experience, Athens, Greece, May 10-13, 1983, pp 14-1 - 14-17 (AD-A137 607)
AD-P002 708

Key Words: Crash research (aircraft), Helicopters, Crashworthiness

This paper discusses the evolution of crash survival design criteria, its influence on the formulation of a US Army military standard for rotary-wing aircraft crashworthiness, and its application to current and new-generation Army helicopters. Emphasis is given to the need for a total systems' approach in design for crashworthiness and the necessity for considering crashworthiness early in the design phase of a new aviation weapon systems development effort. The actual application of crashworthiness to Army helicopters is presented with statistics that show dramatic reductions in fatalities and injuries with implementation of a crashworthy fuel system.

MISSILES AND SPACECRAFT

(Also see Nos. 2307, 2323)

84-2177

Validation Methods for Mathematical Models of Flexible Satellite Dynamics (Methodes de Validation des Modeles Mathematiques en Dynamique des Satellites Non Rigides)

C.A. Darmon
Institut National de Recherche d'Informatique et d'Automatique, Rocquencourt, France, Rept. No. ESA-CR-(P)-1794, 303 pp (1983)
N84-17241
(In French)

Key Words: Satellites, Rotating structures, Mathematical models

The linear equations of the dynamics of a rotating or three axis stabilized satellite are analyzed, using a second order Lagrange, a frequential, modal and a variable state model. Satellite sensor equations are solved. It is shown that satellite nonvibration modes are not observed by accelerometers and gyrometers. A fast Fourier transformation nonparametric method which identifies system order is presented. Parameter identification conditions for a second order model are established, and a maximum likelihood estimate algorithm for model parameters is described.

84-2178

SSME Structural Dynamic Model Development

M.J. Foley, D.M. Tilley, and C.T. Welch
Lockheed Missiles and Space Co., Inc., Huntsville, AL, Rept. No. LMSC-HREC-TR-D867307, NASA-CR-170960, 281 pp (Dec 1983)
N84-17287

Key Words: Space shuttles, Mathematical models

A mathematical model of the space shuttle main engine as a complete assembly, with detailed emphasis on LOX and high fuel turbopumps is developed. The advantages of both complete engine dynamics and high fidelity modeling are incorporated. Development of this model, some results, and projected applications are discussed.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

84-2179

Study on Shock Absorbing Properties of Protective Helmet

M. Shimojo and K. Ban

Industrial Products Res Inst., MITI, 1-1-4, Yatabe-Machi, Higashi, Tsukuba-Gun, Ibaraki 305, Bull. JSME, 27 (225), pp 553-560 (Mar 1984) 21 figs, 18 refs

Key Words: Helmets, Shock absorption

This report describes the shock absorbing properties of a helmet-head system. An equivalent analysis model of a helmet is estimated from the mobility curves which are obtained by experiments. Changes in the parameters of this model at temperatures from -20°C to +40°C are measured. The maximum strain criterion model is chosen to estimate the damage of the head by an impact; hence the influence of impact to the helmet-head system, which is formed in these two models, is clarified by simulation.

84-2180
Improved Off-Road Tractor Ride via Passive Cab and Seat Suspensions

S. Rakheja and S. Sankar
Concordia Univ., Montreal, Canada, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 305-313 (Apr 1984) 11 figs, 6 tables, 21 refs

Key Words: Suspension systems (vehicles), Tractors

Low frequency terrain-induced vibrations transmitted to off-road vehicle operators are quite severe and exceed ISO specified fatigue-decreased-proficiency limits. Ride improvement of an agricultural tractor is investigated via passive suspensions at the seat and/or cab for their relatively simpler adaptability to an existing tractor construction. The investigation is carried out in three phases: seat suspension incorporating bounce, longitudinal, lateral, roll, and pitch modes on a rigidly mounted cab; cab suspension with a rigidly mounted seat; and seat suspension in bounce, bounce-lateral, and bounce-roll, mounted on a suspended cab.

84-2181
Optimal Design of an Off-Road Motorcycle Suspension

M. van Vliet and S. Sankar
Dept. of Mech. Engrg., Concordia Univ., Montreal, Quebec, Canada, H3G 1M8, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 298-304 (Apr 1984) 13 figs, 3 tables, 8 refs

Key Words: Suspension systems (vehicles), Motorcycles, Off-highway vehicles, Time domain method, Frequency domain method

An optimal design is proposed which can be used by the suspension designer to maximize the performance of a given motorcycle suspension. The subject matter is developed by presenting an analytical model of the suspension. A digital simulation is performed in both the frequency and time domains. A set of performance criteria is established based on the results obtained in both domains. Objective functions are formulated based on the performance criteria and the range of input values. A numerical optimization technique is used to calculate the optimal parameters.

84-2182
Optimization for Vibration Isolation

W.V. Nack
Embry-Riddle Aeronautical Univ., Daytona Beach, FL, Intl. J. Numer. Methods Engrg., 20 (5), pp 915-929 (May 1984) 8 figs, 2 tables, 15 refs (Also published as Rept. No. AFOSR-TR-84-0012, 30 pp, Aug 1983, AD-A137 895)

Key Words: Optimization, Vibration isolation

An almost linear optimization problem of importance in vibration isolation has been identified and algorithms were developed to minimize the forced vibrational response of structural systems. The constraints can be either displacements or accelerations. These algorithms have been studied for transient response, frequency response and stationary random using the direct dynamic solution. Multiple response points and loading conditions may be used.

84-2183
Rugged Disk Drives for Hostile Environments

L. Teschler, Staff Ed.
Mach. Des., 56 (5), pp 144-150 (Mar 8, 1984) 7 figs

Key Words: Shock isolation, Computer storage devices

Methods for the protection of Winchester disk drives are reviewed. Shock mounts are used for isolating the head and disk assembly from forces on the outer frame or case. Three features -- carriage locks, spindle locks and landing zones -- help reduce damage caused by forces that get past shock mounts. However, few measures are available to combat condensation on disk surfaces caused by drastic changes in temperature.

84-2184

A Method for Designing Active Flutter Suppression Systems (Eine Methode zur Auslegung des Reglers von aktiven Flatterunterdrückungssystemen)

R. Freymann
Institut f. Aeroelastik der Deutschen Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt (DFVLR), Bunsenstrasse 10, D-3400 Göttingen, Z. Flugwiss. Weltraumforsch., 7 (6), pp 407-416 (Nov/Dec 1983) 11 figs, 12 refs
(In German)

Key Words: Aircraft, Active flutter control

Restriction of the flight envelope due to aircraft flutter can be avoided or eliminated by the use of active flutter suppression systems. Problems encountered during design of active flutter suppression systems are discussed and a new design method is presented. Its practical application is demonstrated based on experimental results.

84-2185

Versatile Damper for Magnetic Suspension Systems

G. Sridharan
Defence Metallurgical Res. Lab., Hyderabad 500 258, India, Rev. Scientific Instrum., 55 (5), pp 806-808 (May 1984) 3 figs, 1 table, 7 refs

Key Words: Magnetic suspension techniques, Viscous damping

Magnetic suspension systems require an optimum amount of damping for stable operation.Viscous damping has proved very effective in controlling the radial instabilities of such systems; however, if the dynamics of the suspension system are not known exactly, it may be advantageous to use a damper having an adjustable coefficient. A new configuration of radial viscous damper, possessing a variable coefficient of damping, is proposed.

84-2186

Some Recent Developments in Structural Control

M.A. Basharkhah and J.T.P. Yao
Purdue Univ., West Lafayette, IN 47906, J. Struc. Mech., 11 (2), pp 137-152 (1983) 2 figs, 22 refs

Key Words: Seismic design, Seismic isolation, Active vibration control

To reduce the effect of lateral earthquake ground motion on structures, active control systems can be used. During the last several decades, many different approaches have been applied to find a suitable gain matrix for the control law. Several recent investigations are summarized and reviewed. A technique based on the system identification method is developed and presented.

84-2187

Effect of Structural Flexibility on the Design of Vibration-Isolating Mounts for Aircraft Engines

W.H. Phillips
NASA Langley Res. Ctr., Hampton, VA, Rept. No. L-15704, NASA-TM-85725, 24 pp (Feb 1984) N84-16590

Key Words: Vibration isolators, Aircraft engines

Previous analyses of the design of vibration-isolating mounts for a rear-mounted engine to decouple linear and rotational oscillations are extended to take into account flexibility of the engine-mount structure. Equations and curves are presented to allow the design of mount systems and to illustrate the results for a range of design conditions.

84-2188

The Cruciform Dynamic Vibration Absorber

J.C. Snowdon, A.A. Wolfe, and R.L. Kerlin
Pennsylvania State Univ., University Park, PA 16802, J. Acoust. Soc. Amer., 75 (6), pp 1792-1799 (June 1984) 11 figs, 3 refs

Key Words: Dynamic vibration absorption (equipment)

The cruciform dynamic absorber comprises two free-free beams that are mass loaded at their free ends and that are joined centrally at right angles at a point at which they are attached to the vibrating item or structure of concern. Both a lumped simple system and distributed mechanical systems such as beams and clamped circular plates are considered. The damping of the absorber beams and of the lumped and distributed mechanical systems is assumed throughout to be of the solid type. The branches (arms) of the cruciform dynamic absorber are generally tuned to the fundamental and second or third resonances of the distributed mechanical systems considered.

TIRES AND WHEELS

84-2189

On the Acoustic/Dynamic Characteristics of the Resilient Wheel (Part 3; Comparisons of Axial Dynamic Characteristics of a Resilient Wheel with Those of Other Anti-Noise Ones)

H. Arai

Railway Technical Res. Inst., JNR, Kikubunji, Japan, Bull. JSME, 27 (225), pp 545-552 (Mar 1984) 14 figs, 1 table, 6 refs

Key Words: Wheels, Flexural vibration, Disks, Transverse shear deformation effects, Rotatory inertia effects

As a part of the study on the acoustic/dynamic characteristics of a resilient wheel, the flexural vibrations of the wheel were investigated. The wheel was regarded as a composite circular disk and approximate dynamic characteristics were calculated. The accuracy of the analysis was improved by considering shear deformation and rotatory inertia of the ring type model. Impulse tests for various types of full size wheels were carried out and their dynamic characteristics were examined.

84-2190

The Calculation of the Acoustical Quantities of Railway Wheels

H. Irretier and E. Schneider

Institut f. Mechanik, Universität Hannover, Hannover, Fed. Rep. Germany, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 278-285 (Apr 1984) 13 figs, 1 table, 21 refs

Key Words: Wheels, Railway wheels, Disks, Variable cross section, Sound generation

The objective of the present investigation is to determine the forced vibrations and acoustical characteristics of a wheel disk with a radially varying thickness from the consideration of axisymmetric and nonaxisymmetric bending vibrations. Using Mindlin's thick plate theory a finite element approximation to describe the natural vibrations of the disk is applied. The forced response of the wheel is derived as the superposition of the natural modes of vibrations using a modal expansion analysis. With the known vibrating velocity on the surface of the wheel disk the sound pressure and the spatial directivity pattern is determined.

84-2191

A Multibody Approach for Dynamic Investigation of Rolling Systems

J. Cl. Samin

Univ. of Louvain, B-1348 Louvain La Neuve, Belgium, Ing. Arch., 54 (1), pp 1-15 (1984) 9 figs, 15 refs

Key Words: Interaction: wheel-pavement

A multibody model is presented where each wheel-ground contact is considered as an internal joint of the system. Some of the geometrical constraints are taken into account by means of closed-loops and generated automatically by a program. The remaining constraints have a simple expression and allow the contact forces and the characteristics of the rolling-path to be introduced in a straightforward manner. The equations of motion of a two-wheel system moving in a plane on a non-rectilinear path are derived to illustrate the method.

84-2192

Spectral Correlation Techniques Applied to Evaluate Noise and Safety Tradeoffs in Tire/Pavement Interaction

T.G. Clapp and A.C. Eberhardt

North Carolina State Univ., Raleigh, NC 27650, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 258-262 (Apr 1984) 9 figs, 3 tables, 8 refs

Key Words: Interaction: tire-pavement, Spectrum analysis, Noise generation

Relationships between pavement surface geometry, truck tire sound, and skid number are investigated to provide an understanding of the tire/pavement interaction mechanism. Correlation techniques are used to determine the relationship between each pair of the three parameters.

84-2193

Instrumented Car Responses During Obstacle Envelopment by Rolling Tires

M. Muthukrishnan

The General Tire & Rubber Co., Akron, OH, SAE Paper No. 830161

Key Words: Tires, Interaction: tire-wheel, Vibration transfer, Noise transmission

Experimental studies were carried out to obtain instrumented car responses during impact with a simulated road obstacle. A cleat 2" wide x 0.5" high x 15" long was employed to simulate tar strip-like road irregularities. The tests were conducted both on the roadwheel and on the road. Two automobiles of different weights were used with two different size tires. Test speeds were 30, 50 and 60 mph. The axle accelerations, the floor acceleration and the interior noise were measured. The time and frequency domain characteristics were determined for all the test data.

BLADES

(Also see No. 2362)

84-2194

Sequential Quadratic Programming and Dynamic Optimal Design of Rotating Blades

Cheng Kengtung and Yuanxian Gu

Dalian Inst. of Tech., Dalian, People's Rep. China, J. Struc. Mech., 11 (4), pp 451-464 (1983-84) 4 figs, 1 table, 10 refs

Key Words: Blades, Rotors, Optimization, Nonlinear programming, Computer programs, Finite element technique

By studying the Kuhn-Tucker conditions for a structural optimal design problem with multifrequency constraints, it is shown that the optimality criterion approach and mathematical programming can be unified. This unification leads to a new approach -- sequential quadratic programming (SQP) -- which is combined with a technique of temporary relaxation of constraints and application of rational move-limits, based on deviations due to linearization of nonlinear constraints. The SQP algorithm is applied to solve the dynamic optimal design problem of rotating blades with prescribed multifrequency constraints on both flapping and chordwise vibration. A computer program based on the finite element method and explicit design sensitivities is developed and a set of examples is tested.

84-2195

Flutter of Swept Fan Blades

R.E. Kielb and K.R.V. Kaza

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. E-1921, NASA-TM-83547, 12 pp (1984)
N84-16587

Key Words: Blades, Fan blades, Flutter

The effect of sweep on fan blade flutter is studied by applying the analytical methods developed for aeroelastic analysis of advance turboprops. Two methods are used. The first method utilizes an approximate structural model in which the blade is represented by a swept, nonuniform beam. The second method utilizes a finite element technique to conduct modal flutter analysis. For both methods the unsteady aerodynamic loads are calculated using two dimensional cascade theories which are modified to account for sweep.

84-2196

Analytical and Experimental Investigations of the Vibrations of a Hollow Blade Model of Turbines

J. Danielski, H. Irretier, O. Mahrenholtz, M. Swaminadham, and E. Vogt

Institut f. Energetik, Technische Hochschule Posen/Polen, Forsch. Ingenieurwesen, 50 (1), pp 1-5 (1984) 5 figs, 1 table, 12 refs

Key Words: Blades, Turbine blades, Natural frequencies, Mode shapes, Finite element technique, Holographic techniques

The results of numerical and experimental investigations of the dynamical behavior of hollow cross-sectioned blades are described. The analytical method consists of modeling the blades by means of a finite-element method to determine the natural frequencies and normal modes. Numerical results are compared with experimental values obtained from holographic tests.

84-2197

Experimental Blade Vortex Interaction Noise Characteristics of a Utility Helicopter at 1/4 Scale

D.A. Conner and D.R. Hoad

NASA Langley Res. Ctr., Hampton, VA, Rept. No. AVSCOM-TR-83-B-1, NASA-TM-84653, 275 pp (Jan 1984)
N84-18018

Key Words: Blades, Propeller blades, Helicopters, Noise generation

Models of both the advanced main rotor system and the standard or baseline UH-1 main rotor system were tested at one-quarter scale in tunnel using the general rotor model system. Tests were conducted over a range of descent angles which bracketed the blade-vortex interaction phenomenon for a range of simulated forward speeds. The tunnel was operated in the open-throat configuration with acoustic treatment to improve the semi-anechoic characteristics of the test chamber. Acoustical data obtained for these two rotor systems operating at similar flight conditions are presented without analysis or discussion.

84-2198

Hydraulic Analogy for Non-Ideal Compressible Gas Flows

J.S. Rao, V.V. Ramana Rao, and V. Seshadri
Indian Inst. of Tech., New Delhi 110016, India, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 267-278, 9 figs, 12 tables, 14 refs

Key Words: Fluid-induced excitation, Blades, Rotor blades (turbomachinery)

The classical hydraulic analogy for a compressible gas flow with specific heat ratio 2 and its limitations are briefly discussed. Correction factors are derived for obtaining a modified hydraulic analogy for gases with any specific heat ratio. Flow through an axisymmetric converging-diverging nozzle is considered for verifying the modified analogy. Analytical gas dynamic solutions are obtained for isentropic, subsonic, and supersonic flows and also flows with normal shocks in the diverging section of the nozzle. Analytical free surface incompressible water table solutions are obtained for the above cases through modified analogy.

84-2199

Forced Vibrations of Rotating Pretwisted Blades

H.M. Jadvani and J.S. Rao
Indian Inst. of Tech., New Delhi, India, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 259-265, 5 figs, 2 tables, 6 refs

Key Words: Blades, Rotor blades (turbomachinery), Forced vibration, Modal analysis

The forced vibration of turbomachine blades is presented. The equations of motion of forced vibrations of pre-twisted, staggered and rotating blade of uniform cross-section are derived using Lagrange's equations. The excitation of the blade is taken in the form of nozzle passing frequency excitation. The effect of rotary inertia and shear deformation is neglected. The forced vibration response is determined by using modal analysis.

84-2200

Effect of Packeting on Turbine Blades Vibrations

R. Bernante and P. Magneschi
ENEL-CRTN, Milan, Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 247-257, 9 figs, 6 tables, 11 refs

Key Words: Blades, Turbine blades, Shrouds

The results of a study of the vibration characteristics of a packet of N turbine blades are presented. By means of a simplified model, it is shown how, from every natural mode of the single blade, a set of N modes appears from the 2^N possible modes (N being the number of blades in the packet). The final configuration does not depend on the absolute value of the stiffness of each part of bandwidth which connects two blades in the packet, but on the ratio between these stiffness values and from the position of the shrouds along the blade. The results of a finite element analysis of a packet of blades 20 inches long belonging to the rotor of a low pressure turbine as a function of the number of blades in the packet are presented.

84-2201

Vibrations of Blades with Damping Wire

M. Butkovic
Jugoturbina, Karlovac, Yugoslavia, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 237-245, 13 figs, 19 refs

Key Words: Blades, Turbine blades, Dampers, Stiffness coefficients

A calculation of natural frequencies of blades with damping wire is described. The stiffness coefficient between blade and wire is unknown. To define this coefficient, a device is made to measure first natural frequency of tangential vibration in static condition with the centrifugal force of damping wire simulated. Comparing calculation and measurement, the value of the stiffness coefficient is received as a function of the centrifugal force intensity; i.e., of the wire and the blade contact pressure. Generalization shows the functional connection between stiffness coefficient and parameter B.

84-2202

Mistuned Bladed Disks - Dynamical Behaviour and Computation

H. Irretier and K.J. Schmidt

Institut f Mechanik, Universitat Hannover, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 215-226, 12 figs, 19 refs

Key Words: Blades, Rotor blades (turbomachinery), Tuning, Component mode synthesis

The effect of mistuning a bladed disk in relation to its eigenfrequencies and mode shapes as well as its response due to excitation is discussed. Different methods for the calculation of the modal quantaties are compared with a special emphasis on the component mode synnthesis. Numerical results are presented which show the eigenfrequencies and mode shapes of two disks, one with one blade shortened against the others and the other carrying blades with statistically distributed mechanical properties.

84-2203

Vibration Analysis of Steam Turbine Pinned Root Control Stage Blades

A.J. Partington

Steam Turbine - Generator Div., Westinghouse Electric Corp., Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 227-235, 11 figs, 7 refs

Key Words: Blades, Rotor blades (turbomachinery), Steam turbines, Fatigue life, Design techniques

Pinned root control stage blades have been used in steam turbines for more than thirty years and are now being used in new turbine designs with higher loading. A research project was recently conducted to improve the accuracy of the vibration design method for this type of blade. Tests were required to obtain more accurate values of pinned root fatigue strength, blade group damping, and partial admission vibratory forces. A finite element computer program was developed for the calculation of frequencies and stresses, and the results were verified by rotating tests. The revised vibration analysis method, based on the results of this project, is described.

84-2204

Comparison of Calculated and Measured Pressures on Straight and Swept-Tip Model Rotor Blades

M.E. Tauber, I.C. Chang, D.A. Caughey, and J.J. Phillipe

NASA Ames Res. Ctr., Moffett Field, CA, Rept. No. A-9584, NASA-TM-85872, 39 pp (Dec 1983) N84-16143

Key Words: Blades, Propeller blades, Helicopters

Using the quasi-steady, full potential code, ROT22, pressures were calculated on straight and swept tip model helicopter rotor blades at advance ratios of 0.40 and 0.45, and into the transonic tip speed range. The calculated pressures were compared with values measured in the tip regions of the model blades. Good agreement was found over a wide range of azimuth angles when the shocks on the blade were not too strong. However, strong shocks persisted longer than predicted by ROT22 when the blade was in the second quadrant.

84-2205

Maximum Resonant Response of Mistuned Bladed Disks

J.C. MacBain and P.W. Whaley

Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 218-223 (Apr 1984) 3 figs, 1 table, 10 refs

Key Words: Blades, Turbine blades, Tuning, Resonant response

The prediction of the maximum resonant response of a mistuned bladed disk having closely spaced dual modes as a function of mode mistuning and modal damping is addressed. A closed form expression is derived for the maximum forced resonant response. A discussion of mistune and damping characteristics of typical turbomachinery bladed disks is also presented.

84-2206

Model Development and Statistical Investigation of Turbine Blade Mistuning

J.H. Griffin and T.M. Hoosac

Carnegie-Mellon Univ., Pittsburgh, PA, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 204-210 (Apr 1984) 12 figs, 14 refs

Key Words: Blades, Turbine blades, Tuning, Resonant response, Statistical analysis

This paper discusses the development of an efficient algorithm which calculates the individual blade response of a

bladed turbine disk, the subsequent statistical investigation to establish mistuning dependencies, and procedures which reduce the increase in blade amplitudes caused by mistuning.

84-2207

Stagger Angle Dependence of Inertial and Elastic Coupling in Bladed Disks

E.F. Crawley and D.R. Mokadam

Massachusetts Inst. of Tech., Cambridge, MA, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 181-188 (Apr 1984) 10 figs, 2 tables, 14 refs

Key Words: Blades, Natural frequencies, Mode shapes

The natural frequencies and mode shapes of nonrotating blade-disk-shaft systems were experimentally and analytically investigated. Two mechanisms of blade motion coupling by the disk and shaft were investigated: inertial coupling by the rigid body motion of the disk on a flexible shaft and out-of-plane elastic coupling due to disk flexure. A Ritz analysis was carried out which identifies the nondimensional frequency and mass ratios which govern the blade-disk-shaft coupling. The mass ratios depend directly on the effective blade stagger angle. Estimates of these parameters were made for three typical rotors.

84-2208

Vibration Modes of Packeted Bladed Disks

D.J. Ewins and M. Imregun

Imperial College of Science and Tech., London, UK, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 175-180 (Apr 1984) 7 figs, 3 tables, 9 refs

Key Words: Blades, Turbine blades, Natural frequencies

Results of investigating the vibrational behavior of turbine blades when grouped into packets are presented. Two methods of analysis based on substructuring via receptance coupling were developed and used with success to predict the natural frequencies of a 30-bladed disk with various packeting arrangements. A series of experiments were conducted on a special testpiece to confirm these predictions. It was found that, unlike its continuously shrouded counterpart, the packeted bladed disk has modes which are always complex in shape, containing several nodal diameter components, a feature which can be predicted from the modal interference diagrams introduced in this work.

84-2209

Vibrations of Twisted Rotating Blades

A.W. Leissa, J.K. Lee, and A.J. Wang

Ohio State Univ., Columbus, OH, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 251-257 (Apr 1984) 4 figs, 5 tables, 22 refs

Key Words: Blades, Turbomachinery blades, Plates

In a previous paper a two-dimensional analytical procedure was developed and demonstrated on simple models of blades having camber. The procedure utilizes shallow shell theory along with the classical Ritz method for solving the vibration problem. Displacement functions are taken as algebraic polynomials. In the present paper the method is demonstrated on blade models having camber. Comparisons are made with results in the literature for nonrotating twisted plates. A method for depicting mode shape information is demonstrated. The analytical procedure is demonstrated on rotating twisted blade modes, both without and with camber.

84-2210

Turbine Blade Testing Methods

Univ. of Cincinnati, OH, Rept. No. NASA-CR-170982, 80 pp (1984)

N84-18201

Key Words: Blades, Turbine blades, Testing techniques, Experimental modal analysis

Testing procedures which could be used to model test turbine blades are developed. The methods studied were methods which used and extended current modal testing procedures. An acoustical impacting testing method was perfected for testing small turbine blades.

84-2211

Blade Fatigue

N.F. Rieger

Stress Technology, Inc., Rochester, NY, Intl. Fed. of Theory of Machines and Mechanisms, 6th Congress, Tech. Committee on Rotordynamics Session Proc., Indian Inst. of Tech., New Delhi, India, Dec 19, 1983, pp 66-88, 16 figs, 7 tables, 150 refs

Key Words: Blades, Fatigue life, Turbine blades, Computer programs

The nature of the blade fatigue problem is discussed. Factors which are known to influence blade fatigue are the steady and alternating stresses from centrifugal and gasdynamic loading, the material strength properties, crack propagation resistance, chemistry of the working environment, and the time-history of the blade loadings. Major publications from the literature of these topics are reviewed. A general-purpose computer code for blade life evaluation, BLADE, is described.

84-2212

The Compressible Aerodynamics of Rotating Blades Using an Acoustic Formulation

L.N. Long

Ph.D. Thesis, The George Washington Univ., 126 pp (1983)

DA8324481

Key Words: Blades, Propeller blades, Aerodynamic loads, Helicopters

This work develops a theoretical formulation for the pressure on the surface of an arbitrary body moving subsonically through a compressible fluid. It also describes a method for solving the resulting integral equation numerically. Important applications exist in the areas of propeller, helicopter, and wing theory.

84-2213

Vibrations of Bladed-Disk Assemblies - A Selected Survey

A.V. Srinivasan

United Technologies Res. Ctr., East Hartford, CT, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 165-168 (Apr 1984) 46 refs

Key Words: Blades, Jet engines, Vibration analysis, Reviews

The progress made in the decade 1973-1983 in the area of vibration of jet engine blades is surveyed. The purpose of the survey is to provide a general review of recent progress and the limited number of references cited can be used to reach the many other important publications in this area. Both structural and aerodynamic aspects of blade vibration are discussed. The areas of future analytical and experimental research needed to continue to influence the design of these components are outlined.

84-2214

Resonant Vibration Levels of a Mistuned Bladed Disk

D.J. Ewins and Z.S. Han

Imperial College of Science and Tech., London, UK, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 211-217 (Apr 1984) 6 figs, 3 tables, 8 refs

Key Words: Blades, Turbine blades, Tuning, Resonant response

Using a simplified but representative model for a mistuned bladed disk, a series of case studies has been made to examine in detail the influence of various parameters on the resonant response levels of each blade on the disk. Although confined to a specific model of a 33-bladed disk, and thus not attempting to generalize its results, the study examines systematically the importance of individual blade mistune, precision of individual blade data, position in an arrangement, and type of arrangement.

BEARINGS

(Also see No. 2331)

84-2215

Operating Characteristics of Three-Lobe and Pressure Dam Bearings

R.D. Flack

Univ. of Virginia, Charlottesville, VA, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 417-428, 23 figs, 13 refs

Key Words: Bearings, Vibration control

Rotating machinery is often subject to vibrations due to critical speeds, unbalance, and instability. Usually the least expensive modification to make in a machine is the bearing. A wide variety of bearings have been developed to combat some of the different types of vibration problems. This paper discusses theoretical and experimental results which have been obtained for two fixed pad bearing types: three-lobe and pressure dam. Geometries are varied and load capacities, rotor-bearing stabilities, and unbalance responses are studied.

84-2216

Study of Some Effects of Hydrodynamic Bearings Non-Linear Behaviour on Rotating Machine Operation

A. Pons
E.D.F. Direction des Etudes et Recherches, 92141 Clamart Cedex, France, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 397-406, 11 figs, 13 refs

Key Words: Bearings, Rotating machinery

A numerical analysis program for static and dynamic behavior of a general shaft-bearing-support system including a nonlinear behavior model for hydrodynamic fluid films is presented. A modal representation of the shaft and the supporting system is used to reduce computational effort. The rotors are represented by a set of pinned-pinned and free-free modes derived from a beam finite elements model.

84-2217

Influence of Misalignment of Support Journal Bearings on Stability of Multi-Rotor Systems

T. Nasuda and Y. Hori
Nuclear Energy Group, Toshiba Corp., Japan, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 389-395, 16 figs, 2 tables, 4 refs

Key Words: Bearings, Journal bearings, Alignment, Computer programs

The effect of misalignment of bearings on the stability of a multi-rotor system is described. The effect of not only vertical and horizontal misalingment but also that of misalignment in arbitrary direction is discussed.

84-2218

Non-Linear Behaviour of Tilting-Pad Bearings

N. Abdul-Wahed, D. Nicolas, and M.T. Pascal
INSA, 69621 Villeurbanne, France, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 407-416, 9 figs, 2 tables, 14 refs

Key Words: Bearings, Tilting-pad bearings, Unbalanced mass response

Tilting-pad bearing sensitivity to unbalance loading is examined and compared with equivalent fixed geometry bearings (three lobe and three lobe offset). The parameters compared are the minimum film thickness and the dynamic transmissibility. The dynamic behavior of a recent three-pad design bearing with the top pad flexibly mounted is also examined.

84-2219

The Determination of the Hydrodynamic Oil Film Force Coefficients by In-Situ Testing

R.H. Bannister and A.R. Tawfik
Cranfield Inst. of Tech., Cranfield, UK, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 379-388, 10 figs, 1 ref

Key Words: Bearings, Oil-film bearings, Mode shapes, Unbalanced mass response

A method is presented in which eight linear oil film force coefficients are obtained by exciting the bearing supporting structure with the rotor in-situ and while operating under its normal speed and load conditions. In order to test the reliability of the proposed technique, measured coefficients were obtained and used to compute the mode shape for a given unbalance configuration, which was then compared with the test rotor having the same unbalance distribution.

84-2220

Experimental Study of Oil Film Thickness, Journal Paths, Angular Misalignment, and Clearance Variation in Diesel Engine Main Bearings

J.L. Charron
Centre Technique des Industries Mecaniques, Senlis, France, ASME Paper No. 84-DGP-6

Key Words: Bearings, Fluid-film bearings

Measurements are presented which describe the behavior of an intermediate and center main bearing in a 4-stroke 4-cylinder 630 kW engine. The oil film thickness and the pressure are plotted versus the time at various speeds and loads.

84-2221

Effect of Fluid Inertia and Viscoelasticity in Squeeze-Film Damper Bearings

J.A. Tichy

Rensselaer Polytechnic Inst., Troy, NY, Rept. No. ARO-17064.7-EG, 28 pp (Jan 1984)
AD-A138 054

Key Words: Bearings, Squeeze film bearings, Squeeze film dampers

In the modeling and analysis of rotor dynamic systems, the behavior of squeeze film damper bearings is normally predicted by the Reynolds equation of hydrodynamic lubrication. Large bearing gaps and high speeds can combine to create conditions in practical applications where fluid inertia and viscoelastic effects may become significant, violating the assumptions under which Reynolds equation can be applied. The analysis shows that the results of lubrication theory can be greatly in error with regard to phase effects between bearing forces and displacements, which may have profound implications regarding critical speed and forced response behavior. Very large deviations from lubrication theory have been predicted in a series of analytical papers under this contract. In the present study direct measurements of damper forces are presented for the first time.

84-2222

Experimental Study of Uncentralized Squeeze Film Dampers

R.D. Quinn

Dept. of Mech. Engrg., Univ. of Akron, Akron, OH, Rept. No. NAUFP-202-2, NASA-CR-168317, 127 pp (Dec 1983)
N84-19927

Key Words: Bearings, Squeeze-film bearings, Rotors, Vibration analysis

The vibration response of a rotor system supported by a squeeze film damper (SFD) was experimentally investigated in order to provide experimental data in support of the rotor/stator interactive finite element theoretical development. Part of the investigation required the designing and building of a rotor/SFD system that could operate with or without end seals in order to accommodate different SFD lengths. SFD variables investigated included clearance, eccentricity mass, fluid pressure, and viscosity and temperature.

84-2223

Measurements of Squeeze Film Bearing Forces to Demonstrate the Effect of Fluid Inertia

J.A. Tichy

Rensselaer Polytechnic Inst., Troy, NY, ASME Paper No. 84-FT-11

Key Words: Bearings, Squeeze film bearings, Fluid induced excitation

Direct measurements of damper forces are presented for the first time. Reynolds numbers up to 10 are obtained at eccentricity ratios 0.2 and 0.5. Lubrication theory underpredicts the measured forces by up to a factor of two (100% error). Qualitative agreement is found with predictions of earlier improved theories that include fluid inertia forces.

84-2224

Predicting the Effects of Structural Distortions on the Performance of Large-Diameter Rolling Bearings

R.A. Pallini

Franklin Res. Ctr., Philadelphia, PA 19103, Lubric. Engrg., 40 (5), pp 267-273 (May 1984) 9 figs, 16 refs

Key Words: Bearings, Rolling contact bearings, Design techniques, Damage prediction

Large-diameter special-configuration ball and roller bearings utilize rolled, steel rings with relatively narrow cross sections. This results in bearing raceways that are low in structural stiffness. They can conform to the structural surroundings, which may be deformed. If not understood during the design stage, these structural distortions can result in increases in ball and roller loadings. This can seriously effect bearing performance and lead to premature failure. This paper shows how computer-aided design tools can be used to predict the effects of structural distortions upon the performance of three common special-configuration bearing designs.

GEARS

84-2225

Influence of Gear Errors on Rotational Vibration of Power Transmission Spur Gears (1st Report, Pressure Angle Error and Normal Pitch Error)

K. Umezawa, T. Sato, and K. Kohno

Res. Lab. of Precision Machinery and Electronics, Tokyo Inst. of Tech., Nagatsuta, Midori-ku, Yokohama 227, Japan, Bull. JSME, 27 (225), pp 569-575 (Mar 1984) 16 figs, 15 refs

Key Words: Gears, Spur gears, Power transmission systems, Initial deformation effects

In this study, a power transmission spur gear is preferably a profile corrected spur gear. Assuming the given value deviates about ten-odd percent from the actual acceleration, it is synthesized how a pressure angle error and a normal pitch error influence the vibration of profile corrected spur gears, using the simulator developed by the authors, whose output depicts precisely the experimental behavior. A practical equation for the vibration of profile corrected gears having some errors is proposed.

COUPLINGS

84-2226

Operation Peculiarities of Couplings with Rigidity Changes in Steps

A. Jakstas, B. Spruogis, V.A. Zabielskas

Vilnius Civil Engrg. Inst., Vilnius, Lithuanian SSR, Dynamics and Strength of Machinery and Structures, 25th Proc. in Mechanics, Vilnius Civil Engrg. Inst., Lithuanian SSR, 1983, pp 115-127, 7 figs, 2 refs (In Russian)

Key Words: Couplings, Torsional response

The article deals with elastic couplings, the rigidity of which increases suddenly when a certain value of torque is achieved. This is obtained by changing the deformation conditions of the elastic element or by preventing the latter from transmitting the load. The transition conditions from one state to the other are defined and equations to define the main parameters of the couplings are presented.

84-2227

Compensating Characteristics of Special Coupling

J. Jurevicius

Vilnius Civil Engrg. Inst., Vilnius, Lithuanian SSR, Dynamics and Strength of Machinery and Structures, 25th Proc. in Mechanics, Vilnius Civil Engrg. Inst., Lithuanian SSR, 1983, pp 104-114, 6 figs (In Russian)

Key Words: Couplings, Stiffness coefficients

Compensating characteristics of an elastic coupling are determined. The radial stiffness component of the elastic forces is determined by first expressing potential energy of rings by fictitions forces and the coefficients of influence and then by stiffness coefficients.

FASTENERS

84-2228

Improving the Fatigue Performance of Thick Aluminium Alloy Bolted Joints by Hole Cold-Expansion and the Use of Interference-Fit Steel Bushes

J.Y. Mann, G.W. Revill, and W.F. Lupson

Aeronautical Res. Labs., Melbourne, Australia, Rept. No. ARL/STRUC NOTE-486, 75 pp (Apr 1983) AD-A137 771

Key Words: Joints (junctions), Bolted joints, Aluminum, Fatigue life, Fatigue tests

Fatigue tests under a flight-by-flight loading sequence have been carried out on small bolted joint specimens of 23 mm thickness representing part of the spar rear flange/skin attachment in Mirage III aircraft. The investigation has shown that by cold-expanding the bolt holes to take standard oversize bolts, or by installing interference-fit bushes, the fatigue life can be more than doubled compared with the use of standard close-fit bolts in reamed holes.

84-2229

Bending Fatigue of Electron-Beam-Welded Foils. Application to a Hydrodynamic Air Bearing in the Chrysler/Doe Upgraded Automotive Gas Turbine Engine

J.F. Saltsman and G.R. Halford

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. DOE/NASA/51040-51, NASA-TM-83539, 27 pp (Jan 1984) N84-16589

Key Words: Joints (junctions), Welded joints, Bearings, Fatigue tests

A hydrodynamic air bearing with a compliment surface is used in the gas generator of an upgraded automotive gas turbine engine. In the prototype design, the compliant surface is a thin foil spot welded at one end to the bearing cartridge. During operation, the foil failed along the line of spot welds which acted as a series of stress concentrators. Because of its higher degree of geometric uniformity, elec-

tron beam welding of the foil was selected as an alternative to spot welding. Room temperature bending fatigue tests were conducted to determine the fatigue resistance of the electron beam welded foils. Equations were determined relating cycles to crack initiation and cycles to failure to nominal total strain range.

SEALS

84-2230
Dynamic Behavior of Spiral-Groove and Rayleigh-Step Self-Acting Face Seals

E. Dirusso

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. E-1754, NASA-TP-2266, 19 pp (Jan 1984)
N84-16181

Key Words: Seals

Tests were performed to determine the dynamic behavior and establish baseline dynamic data for five self-acting face seals employing Rayleigh-step lift-pads and inward pumping as well as outward-pumping spiral grooves for the lift-generating mechanism. The primary parameters measured in the tests were film thickness, seal seat axial motion, and seal frictional torque. The data show the dynamic response of the film thickness to the motion of the seal seat.

84-2231
Seal Part Supported on Rotor Disc Lug

A.P. Matheny

Dept. of the Air Force, Washington, DC, U.S. Patent Appl. No. 6-564-548

Key Words: Seals, Rotors

In a turbine engine, an improved seal part support arrangement envisions mounting the rotating parts of the sealing structure on extensions of the rotor disc lugs which mount the root portions of the turbine blades. Thus, the seal parts are mounted in tandem relationship to the blade root portions and form an annular ring.

84-2232
Rotordynamic Moment Coefficients for Finite-Length Turbulent Seals

D.W. Childs

Texas A&M Univ., College Station, TX 77843, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 371-378, 2 figs, 12 refs

Key Words: Seals, Centrifugal pumps

Expressions are derived which define dynamic coefficients for high-pressure annular seals typical of wear-ring and interstage seals employed in multi-stage centrifugal pumps. The results show that the force and moment rotordynamic coefficients are not independent; i.e., seal misalignment influences the force coefficients, and seal displacement influences the moment coefficients. Numerical results demonstrate both these inter-relationships and the influence of L/D ratios on the moment coefficients.

84-2233
Exciting Forces Due to Swirl-Type Flow in Labyrinth Seals

L. Hauck

Lehrstuhl f. Thermische Kraftanlagen, Technische Universität Munchen, Germany, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 361-369, 13 figs, 18 refs

Key Words: Seals, Fluid-induced excitation

An improved model to evaluate labyrinth flows and resulting forces on a rotor is presented. Two spatial separated flow areas are considered within the labyrinth cavities.

84-2234
Experimental Research on the Behaviour of Hydrodynamic Plain Seals by Means of a Specific Testing Device (A.P.S.A.L.)

M. Falco, G. Diana, G. Marenco, and P. Saccenti Inst. of Machines, Univ. of Catania, Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 355-360, 6 figs, 9 refs

Key Words: Seals, Pumps, Measuring instrumentation, Elastic properties, Damping coefficients

A method is presented for experimental determination of the elastic and damping characteristics of a centrifugal pump's interstage seals. The special experimental device is described together with the data measurement and acquisition system. A short exposition of the problems involved with the measurement organization and interpretation is given.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

84-2235

Resonant, Nonplanar Motion of a Stretched String

J. Miles

Inst. of Geophysics and Planetary Physics, Univ. of California, LaJolla, CA 92093, J. Acoust. Soc. Amer., 75 (5), pp 1505-1510 (May 1984) 3 figs, 1 table, 11 refs

Key Words: Strings, Harmonic excitation

The weakly nonlinear, nonplanar, resonant response of a stretched string to simple harmonic, planar excitation is examined in a four-dimensional phase space in which the coordinates are slowly varying amplitudes of a sinusoidal motion of the dominant mode at the driving frequency.

CABLES

84-2236

Five Years' Field Trials of Detuning Pendulums for Galloping Control

D.G. Havard and J.C. Pohlman

Ontario Hydro, Toronto, Canada, Power Apparatus Syst., IEEE Trans., PAS-103 (2), pp 318-327 (Feb 1984) 8 figs, 2 tables, 18 refs

Key Words: Transmission lines, Cables, Galloping, Vibration control, Pendulums

Field trials of detuning pendulums for controlling galloping of iced conductors have been in place on operating single and bundle conductor lines for five years and have generated considerable observational data. A technique of analysis has been developed which permits these observations of galloping on conductors with detuning pendulums to be compared with those on similar untreated conductors for a range of single conductor sizes in the data bank.

BARS AND RODS

84-2237

Stability of a Bar Inside a Rotating Tube

V. Paliunas and N. Rudgalviene

Kaunas Polytechnic Inst., Kaunas, Lithuanian SSR, Dynamics and Strength of Machinery and Structures, 25th Proc. in Mechanics, Vilnius Civil Engrg. Inst., Lithuanian SSR, 1983, pp 73-83, 2 figs, 2 refs

(In Russian)

Key Words: Bars, Tubes, Rotating structures, Concentric structures, Stability

The stability of a bar inside a tube and parallel to the walls of the tube is investigated. It is assumed that an axial force is acting on the bar. An approximate solution of the differential equation, describing the equilibrium of the bar, gives an approximate minimum value of the critical force. When the axial force acting on the bar exceeds this critical value the bar loses its stability.

BEAMS

84-2238

Deflection and Vibration in Shear-Deformable Beams and Laminated Composites Made of Bimodular and Multimodular Materials

F. Gordaninejad

Ph.D. Thesis, Univ. of Oklahoma, 164 pp (1983)

DA8404565

Key Words: Beams, Layered materials, Vibration analysis

A transfer-matrix analysis is presented for determining the static and dynamic behavior of thick, orthotropic beams of multimodular materials (i.e., materials which have different elastic behavior in tension and compression, with nonlinear stress-strain curve approximated as piecewise linear, with four or more segments). Also, an exact solution is presented for cases in which the neutral-surface location is constant

along the beam axis. Results for axial displacement, transverse deflection, bending slope, frequency, bending moment, transverse shear force, axial force, and location of neutral surface are presented for different load and boundary conditions.

84-2239

On the Flexural Vibrations of Arms with Variable Length. An Exact Solution

S. Bergamaschi and A. Sinopoli

Inst. of Appl. Mech., Univ. of Padua, Italy, Mech. Res. Comm., 10 (6), pp 341-345 (Nov/Dec 1983) 2 figs 2 refs

Key Words: Beams, Cantilever beams, Flexural vibration

Free flexural vibrations of a cantilever arm with increasing length are studied. An exact analytical solution is found, valid when the length changes linearly, and results for the amplitudes and frequencies of each mode are given.

84-2240

A Simple Element for Static and Dynamic Response of Beams with Material and Geometric Nonlinearities

T.Y. Yang and S. Saigal

Purdue Univ., West Lafayette, IN, Intl. J. Numer. Methods Engrg., 20 (5), pp 851-867 (May 1984) 10 figs, 28 refs

Key Words: Beams, Frames, Finite element technique

A unified simple 6 degrees-of-freedom beam finite element and the associated computational procedures have been developed for the fast and efficient solution of a wide class of static and dynamic response problems of the beam type with material and/or geometrical nonlinearities. The material nonlinearity is treated by including its effect in the governing equations by forming the stiffness matrix of each element using a two-dimensional grid of Gauss points and using the material properties at each point corresponding to the uniaxial strain at that point. Examples are provided for metal and reinforced concrete beams.

FRAMES AND ARCHES

(See No. 2240)

84-2241

Impact Response of a Circular Membrane

C.L. Farrar

Royal Military College of Science, Shrivenham, Swindon, Wilts, SN6 8LA, UK, Expt. Mech., 24 (2), pp 144-149 (June 1984) 5 figs, 6 refs

Key Words: Membranes, Circular membranes, Impact response

The transverse deformation of a finite-circular membrane after normal impact by a blunt projectile is investigated. A separation-of-variables technique is used to solve the governing two-dimensional-membrane equation. From observations obtained from a high-speed film of the impact, it is shown that the predicted displacements are in close agreement with experimentation.

PANELS

84-2242

Frames with Staggered Panels: Experimental Study

K.N.V.P. Rao, K. Seetharamulu, and S. Krishnamoorthy

S.V. Univ., College of Engrg., Tirupati 517 502, India, ASCE J. Struc. Engrg., 110 (5), pp 1134-1148 (May 1984) 13 figs, 4 tables, 4 refs

Key Words: Frames, Panels, Reinforced concrete, Seismic response, Aerodynamic stability

A structural system consisting of story-deep and bay-wide discrete panels to resist lateral loads is investigated. To study the overall behavior of this system and to compare with the conventional shear wall frame, four perspex models were tested for static as well as dynamic response. To investigate the behavior of a discrete shear panel and to study the effect of stress-concentration at panel-corners where skeletal members meet, three reinforced concrete panels were tested. The proposed system is found to provide adequate lateral stiffness to resist horizontal loads such as wind and earthquake forces.

PLATES

(Also see No. 2209)

84-2243

On the Problem of Vibrations of Nonlinear Elastic Electroconductive Plates in Transverse and Longitudinal Magnetic Fields

S.A. Ambartsumian, M.V. Belubekian, and M.M. Minassian

Yerevan State Univ., Yerevan, USSR, Intl. J. Nonlin. Mech., 19 (2), pp 141-149 (1984) 6 tables, 8 refs

Key Words: Plates, Electromagnetic excitation

Nonlinear cylindrical-form vibrations of an electroconductive plate-strip in longitudinal and transverse magnetic fields are considered. For the plate material a nonlinear relationship between stress and deformation is accepted. On the basis of the known hypotheses and assumptions the general system is reduced to one equation for the normal displacement of the plate. Using the Bubnov-Galerkin method and the method of asymptotic integration, the amplitude-frequency characteristics of vibrations are defined.

84-2244

Plate Perforation Phenomena Due to Normal Impact by Blunt Cylinders

J. Liss and W. Goldsmith

University of California, Berkeley, CA 94720, Intl. J. Impact Engrg., 2 (1), pp 37-64 (1984) 15 figs, 3 tables, 12 refs

Key Words: Plates, Impact response, Perforation

An experimental program has been executed to measure the system parameters relevant to the normal impact of both rigid and deformable blunt cylinders against soft 2024-0 aluminium plates over the velocity range from 60-600 m/s, involving speeds just below and well above the ballistic limit. The data are compared to the predictions of a previously developed theory involving rigid/plastic constitutive relations for a five-stage penetration process that includes the dynamic response of the target by means of shear transmitted at the interface, but neglects plate bending.

84-2245

Vibration of a Plate with Arbitrary Shape in Contact with a Fluid

K. Nagaya and J. Takeuchi

Gunma Univ., Kiryu, Gunma 376, Japan, J. Acoust. Soc. Amer., 75 (5), pp 1511-1518 (May 1984) 13 figs, 14 refs

Key Words: Plates, Submerged structures, Natural frequencies, Tanks (containers)

A method for solving vibration problems of arbitrarily shaped plates in contact with a fluid is presented. Expressions of natural frequencies, displacements, and pressures for arbitrary plates in contact with a fluid are obtained with consideration of viscosity of fluid. The analysis applies the exact solution of the equations of motion and the Fourier expansion collocation method for satisfying the boundary conditions. Numerical calculations are carried out for elliptical plates and rectangular plates with round corners in contact with a fluid.

84-2246

Laminarization Effects on the Dynamics of a Disk Levitated by Incompressible Fluid Flow

D.K. Varinner and J.T. Pearson

Argonne National Lab., IL, Rept. No. CONF-840201-7, 13 pp (1984)

DE84003612

Key Words: Disks, Levitation, Equations of motion

This paper develops a nonlinear ordinary differential equation of motion for a disk parallel to a flat plat and levitated by incompressible turbulent fluid flow supplied from a central orifice. The transient flow-velocity and pressure-field for the turbulent flow are found by integrating the time-averaged Navier-Stokes equation with power-law velocity and shear stress correlations.

84-2247

Stress Analysis of Rectangular Walls under Seismically Induced Hydrodynamic Loads

M.A. Haroun

Univ. of California, Irvine, CA 92717, Bull. Seismological Soc. Amer., 74 (3), pp 1031-1041 (June 1984) 5 figs, 3 tables, 8 refs

Key Words: Storage tanks, Concretes, Walls, Plates, Seismic design

Seismically induced bending moments in the walls of rectangular concrete liquid storage tanks are evaluated. The tank is assumed to be subjected to simultaneous horizontal and vertical components of earthquake excitations. The liquid is assumed to be homogeneous, inviscid, and incompressible. *Hydrodynamic pressures are calculated using the classical* potential flow approach and are compared with those obtained from approximate analyses. Typical systems of loadings are identified and applied on the walls which are assumed to behave as elastic plates. Analytical expressions for the computation of internal moments are presented, and numerical values of moment coefficients are tabulated for use in seismic design analysis of tank walls.

SHELLS

84-2248

Circumferential Cracks in Cylindrical Shells

R.W. Nicholson

Ph.D. Thesis, Washington Univ., 221 pp (1983) DA8402180

Key Words: Shells, Cylindrical shells, Fracture properties

Fracture mechanics methodology is developed for investigating axisymmetric part-through cracks in stiffened and unstiffened cylindrical shells. The principle behind the method is coupling equations which describe the behavior of the shell and the crack zone, using basic principles of engineering mechanics.

84-2249

Multiple Modal Resonances of Thin Cylindrical Shells Vibrating in an Acoustic Medium

M.C. Junger and J.M. Garrelick

Cambridge Acoustical Associates, Inc., 54 Rindge Avenue Extension, Cambridge, WA 02410, J. Acoust. Soc. Amer., 75 (5), pp 1380-1382 (May 1984) 2 figs, 7 refs

Key Words: Shells, Cylindrical shells, Natural frequencies

Structural modes of a thin cylindrical shell can display as many as three natural frequencies when immersed in an acoustic medium, all lower than the corresponding in vacuo natural frequency. This phenomenon results from the marked peak displayed by the inertial radiation loading of a slender cylindrical shell when the structural wavenumber of a modal configuration lies close to the acoustic wavenumber. This is illustrated for the axisymmetric breathing mode in the limiting case of an infinitely periodic cylindrical shell. For the parameters of metal shells in water, three natural frequencies are anticipated for modes whose axial wavelength exceeds the radius by at least one order of magnitude.

84-2250

Underwater Shock-Induced Responses of Submerged Cylindrical Structures

F.G. Daube

Naval Postgraduate School, Monterey, CA, 110 pp (Dec 1983)

AD-A139 072

Key Words: Shells, Cylindrical shells, Underwater structures, Shock waves, Computer programs

The nonlinear elasto-plastic responses of a submerged cylindrical shell to an underwater shock wave have been investigated. Using the EPSA (Elasto-Plastic Shell Analysis) code, the gross responses of homogenous and ring-stiffened shells were evaluated. The relevant parameters have been displayed and evaluated using PATRAN-G color graphics system. An interface module was developed between EPSA and PATRAN-G. The deformations and von Mises stresses throughout the shell have been qualitatively evaluated.

84-2251

The Additional Dynamical Analysis of a Simply Supported, Two-Layered Half-Cylindrical Shell

O. Šimková

Institute of Materials and Machine Mechanics of the Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnícky Časopis, 35 (1-2), pp 215-220 (1984) 6 tables, 1 ref

(In Slovak)

Key Words: Shells, Cylindrical shells, Natural frequencies, Mode shapes, Modal analysis

Additional results of frequency and modal analysis are presented for a two-layered half-cylindrical shell with all edges simply supported and with free undamped vibrations taken into consideration.

84-2252

Radiation-Induced Impulse on a Spherical Shell

M.J. Forrestal and M.J. Sagartz

Sandia National Labs., Albuquerque, NM 87185, Intl. J. Impact Engrg., 2 (1), pp 81-84 (1984) 2 figs, 6 refs

Key Words: Shells, Spherical shells, Impulse response

Formulas for the membrane response of a thin, elastic, spherical shell to a radiation-induced impulse load are derived and some numerical results are presented.

84-2253

Dynamic Elastic Buckling of Complete Spherical Shells with Initial Imperfections

B. Song and N. Jones

The Zhejiang Univ., Hangzhou, People's Rep. China, J. Struc. Mech., 11 (3), pp 327-350 (1983) 14 figs, 1 table, 23 refs

Key Words: Shells, Spherical shells, Dynamic buckling, Initial deformation effects

The dynamic elastic buckling behavior of a geometrically imperfect complete spherical shell that is subjected to a uniform external step pressure is examined using Sander's equilibrium and kinematic equations, appropriately modified to include the influence of inertia forces and initial stress-free imperfections in the radius. A finite-difference procedure with either the Houbolt or Park methods of time integration is used to predict the axisymmetric dynamic elastic buckling pressures and associated critical mode numbers.

PIPES AND TUBES

(Also see No. 2361)

84-2254

Experimental Studies of Pipe Impact on Rigid Restraints and Concrete Slabs

J.L. Garcia, Ph. Chouard, and E. Sermet
Commissariat A L'Energie Atomique, CEN/CADARACHE, DRE/STRE, B.P. No. 1, 13115 Saint-Paul-Lez-Durance, France, Nucl. Engrg. Des., 77 (3), pp 357-368 (Feb 1984) 12 figs, 6 tables, 3 refs

Key Words: Pipe whip, Impact response, Slabs, Concretes

Experiments with a three-inch-diameter pressurized pipe whipping against a rigid restraint or a concrete slab are described. Eleven experiments test pipes with various geometries impacting a stiff structure either at an elbow or on a straight segment. Pipe motion, impact force, impact time, and pipe crush are measured. Two experiments with pipe elbows impacting a six-inch-thick and a three-inch-thick reinforced concrete slab are presented.

84-2255

Nonlinear Dynamic Analysis of High Energy Line Pipe Whip

L.C. Hsu, A.Y. Kuo, and H.T. Tang
NUTECH Engineers, Inc., 6835 Via Del Oro, San Jose, CA 95119, Nucl. Engrg. Des., 77 (3), pp 369-379 (Feb 1984) 14 figs, 2 tables, 5 refs

Key Words: Computer programs, Piping systems, Pipe whip

This paper describes a nonlinear dynamic analysis of TVA high energy line pipe whip tests using the ABAQUS-EPGEN code. The analysis considers the effects of large deformation and strain rate on resisting moment and energy absorption capability. The numerical results of impact forces, impact velocities, pipe strain, and reaction forces at pipe supports are compared to the TVA test data. The calculated pipe whip impact time and forces are also compared with those predicted using current industry practice.

84-2256

Piping Extreme Dynamic Response Studies

G.E. Howard, B.A. Johnson, and W.B. Walton
ANCO Engineers, Inc., 9937 Jefferson Blvd., Culver City, CA 90230-3591, Nucl. Engrg. Des., 77 (3), pp 405-417 (Feb 1984) 13 figs, 8 tables, 4 refs

Key Words: Piping systems, Dynamic tests

Results are presented for a series of high-amplitude dynamic tests of a simple pressurized piping system excited through various multiple piping supports. The four-inch diameter piping achieved response levels above yield when subjected to earthquake-like time history inputs and withstood, without leakage or gross distortion, dynamic inputs that were factors of three to five times greater than those inputs required to just exceed the ASME Class 2 stress limit for Service Level D, the Safe Shutdown Earthquake condition.

84-2257

The Influence of High-Frequency Excitation on Piping and Support Design

J. Lockau, E. Haas, and F. Steinwender
Kraftwerk Union, Offenbach, W. Germany, J. Pressure Vessel Tech., Trans. ASME, 106 (2), pp 177-187 (May 1984) 19 figs, 2 tables, 6 refs

Key Words: Piping systems, Supports, High frequency excitation

The effect of a high-frequency excitation on piping systems and supports is demonstrated. The influence of local plasticity on the dynamic behavior is shown in an analytical benchmark. The evaluation of several full-scale experiments

resulted in rather large safety margins between calculated and allowed stresses. The stresses were calculated following the standard nuclear codes. No failure occurred in the tested structures even under extreme overloading. This demonstrates the high capacity of structures to survive dynamic load. A theoretical explanation is found in the effect of energy absorption by plastic deformation.

84-2258

Prediction and Experi nent Comparisons for German Standard Problems 4A: Piping Response to Blowdown

G.E. Howard

ANCO Engineers, Inc., Culver City, CA, 45 pp (Apr 1984)

NUREG/CR-3720

Key Words: Pipelines, Blowdown response

This report consists of comparisons of prediction and experiment for German Standard Problem 4A, a blowdown experiment involving structural dynamic response. The comparisons presented are of the time histories of displacement, bending stress, and bending axis angle. The reasons for error in the predictions are discussed. The structural model is improved to obtain a better match with the experimental natural frequencies.

84-2259

Impact of Changes in Damping and Spectrum Peak Broadening on the Seismic Response of Piping Systems

T.Y. Chuang, S.C. Lu, B.J. Benda, and J.J. Johnson

Lawrence Livermore National Lab., CA, Rept. No. UCRL-53491, 71 pp (Mar 1984)

NUREG/CR-3526

Key Words: Pipelines, Seismic response

Two modifications that affect seismic analysis of piping systems to regulatory guides have been proposed. One modification would change damping values for piping systems specified in Regulatory Guide 1.61. The other modification would provide an alternative to the peak broadening procedure of Regulatory Guide 1.122. The reduction in piping responses of three piping systems in the Zion nuclear power plant resulting from these two modifications, were quantified separately and in combination. It was concluded that the proposed damping values reduce piping response substantially; and the proposed alternative to peak broadening reduces piping response only marginally. The seismic response of the three piping systems were calculated by two methods: response spectrum analysis and multi-support time history analysis.

84-2260

Analysis and Test Correlation of Flexible and Stiff Piping Systems

W.F. Hahn, Y.K. Tang, and H.T. Tang

Impell Corp., 350 Lennon Lane, Walnut Creek, CA 94598, Nucl. Engrg. Des., 77 (3), pp 299-319 (Feb 1984) 22 figs, 4 tables, 4 refs

Key Words: Piping systems, Snubbers, Supports, Seismic analysis

An in situ pipe test program was conducted to provide a basis for evaluating piping analysis methodologies and design philosophies. In this program, a 20.3-cm boiler feedwater line with two fundamentally different support systems was tested and analyzed. One system employed hanger supports and was very flexible. The second system employed strut and snubber supports and was relatively stiff. Snapback and forced vibration tests were performed on the piping systems. The test results were used to determine piping damping values and to correlate with analyses.

84-2261

A Proposal for an Aseismic Design Method of Equipment and Piping for NPPs in a Low Seismicity Area

H. Shibata

Inst. of Industrial Science, Univ. of Tokyo, 22-1, Roppongi 7, Minato-ku, Tokyo 106, Japan, Nucl. Engrg. Des., 77 (2), pp 169-179 (Feb 1984) 7 figs, 2 tables, 11 refs

Key Words: Piping systems, Seismic design

Recently a regulatory code for an aseismic design of high-pressure gas facilities became effective in Japan. This order includes details of the aseismic design of vessels whose factor of importance are relatively lower than Class A (Class I) items in nuclear power plants. The author develops his idea on an aseismic design method of equipment and piping of nuclear power plants in a low seismicity area (L3A) based on his experience of the new code for petro-chemical industries and oil refineries pertaining to high pressure gas facilities mentioned above.

84-2262
DOE/ANL/HTRI Heat Exchanger Tube Vibration Data Bank (Addendum 4)
H. Halle, J.M. Chenoweth, and M.W. Wambsganss
Argonne National Lab., Argonne, IL, Rept. No. ANL-CT-80-3-Add.4, 33 pp (Dec 1983)
DE84005441

Key Words: Tube arrays, Heat exchangers, Case histories, Data processing

This fourth addendum to the DOE/ANL/HTRI Heat Exchanger Tube Vibration Data Bank presents 6 new case histories of field experiences. The data bank was established in 1980 to accumulate comprehensive case histories on heat exchangers that have experienced tube-vibration problems and on units that have been trouble-free, and to render this information available for evaluation, improvement, and development of vibration-prediction methods and design guidelines.

DUCTS

84-2263
Acoustic Radiation from a Semiinfinite Annular Duct in a Uniform Subsonic Mean Flow
S.W. Rienstra
National Aerospace Lab., Amsterdam, The Netherlands, Rept. No. NLR-MP-82045-U, 49 pp (Dec 28, 1982)
N84-19059

Key Words: Ducts, Sound waves, Wave propagation

Using a Wiener-Hopf approach, an analytical description is derived of the scattered field of a harmonic sound wave from an open ended annular duct submerged in a subsonic, coaxial, uniform mean flow. Explicit expressions are given for the acoustic power inside the pipe, in the acoustic far field, and, in the presence of vortex shedding, in the hydrodynamic far field and of the power absorbed by the vortex sheet. Acoustic power loss, due to vortex shedding from the trailing edge, at frequencies near cut-off was studied as a function of Mach number, mode number of the incident wave, and hub radius.

BUILDING COMPONENTS
(Also see No. 2149)

84-2264
Dynamic Centrifuge Testing of Cantilever Retaining Walls
L.A. Ortiz
Soil Mechanics Lab., California Inst. of Tech., Pasadena, CA, Rept. No. SML-82-02, 363 pp (1982)
PB84-162312

Key Words: Walls, Seismic response, Seismic tests

An investigation was made into the behavior of flexible cantilever walls retaining a cohesionless soil backfill and subjected to earthquake-type dynamic excitations using the centrifuge modeling technique. The study was motivated by the abundant observations of earth retaining structure damage and failures documented in earthquake damage reports.

84-2265
Seismic Behavior of Coupled Wall Systems
K.N. Shiu, T. Takayanagi, and W.G. Corley
Portland Cement Assoc., Skokie, IL, ASCE J. Struc. Engrg., 110 (5), pp 1051-1066 (May 1984) 18 figs, 2 tables, 11 refs

Key Words: Walls, Beams, Seismic response

Structural walls connected by short coupling beams were investigated experimentally and analytically. Two one-third scale coupled wall systems were tested with in-plane reversing loads. The systems represented a lightly coupled wall with relatively weak beams and a heavily coupled wall with strong repaired beams.

ELECTRIC COMPONENTS

MOTORS
(See No. 2337)

GENERATORS

84-2266
Application of a Thyristor Controlled VAr Compensator for Damping Subsynchronous Oscillations in Power Systems
A.E. Hammad and M. El-Sadek

BBC Brown Boveri & CIE, 5401 Baden, Switzerland, Power Apparatus Syst., IEEE Trans., PAS-103 (1), pp 198-212 (Jan 1984) 14 figs, 3 tables, 17 refs

Key Words: Subsynchronous vibration, Power plants (facilities), Generators

A new concept is presented for controlling static VAr compensators (SVC) in power systems. It allows thyristor controlled VAr compensators to effectively damp subsynchronous resonance (SSR) oscillations besides controlling the system voltage. Eigenvalue analysis and digital time simulations for the IEEE SSR benchmark system are utilized to investigate the role of the main voltage regulator of the SVC in stabilizing the system and alleviating the SSR modal interactions that may be introduced by the auxiliary speed signal alone. Stability zones are identified to optimize the compensator parameters for economical application.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 2364, 2367)

84-2267

New Ultrasonic Modeling Findings on Rayleigh Wave Propagation and Their Implications

J.R.Chamuel

The Charles Stark Draper Lab., Inc., Cambridge, MA 02139, J. Acoust. Soc. Amer., 75 (5), pp 1495-1504 (May 1984) 8 figs, 20 refs

Key Words: Sound waves, Wave propagation

The presence of unexplained large attenuation of low-frequency components and inverted dispersion of Rayleigh waves crossing the ocean-continent margin, the Tibetan Plateau, and the Iranian Plateau are examples of complex unsolved problems on Rayleigh wave propagation across vertical seismic boundaries. New ultrasonic modeling findings on Rayleigh wave propagation across step changes in elevation using two- and three-dimensional models are described explaining the previously mentioned phenomena. Laboratory seismic ultrasonic modeling results on Tibet are presented matching actual field data. Physical insights into the cause of the inverted dispersion and attenuation are obtained from the experimental results.

84-2268

Undersea Sound Speed and Range Estimation

C.S. Hwang and R.R. Mohler

Oregon State Univ., Corvallis, OR, Rept. No. OSU-ONR-TR-83-7, 38 pp (Oct 1983)
AD-A138 954

Key Words: Underwater sound, Sound propagation

Estimation of an acoustic wave velocity in the ocean and its utilization to improve object localization are studied. Time delay and/or Doppler shift are measured by the vertically deployed sensors in two-dimensional systems. Various sensor configurations (up to three sensors) are considered.

84-2269

New Eigenfunction Expansion and Its Application to Waveguide Acoustics

R.F. Pannantoni

Pannatoni (Ronald F.), Morristown, NJ, 33 pp (Feb 15, 1984)
AD-A138 946

Key Words: Waveguide analysis, Sound waves, Wave propagation

This report describes the application of new eigenfunction expansions to the analysis of sound propagation in a two-dimensional waveguide. One boundary of the waveguide is flat, the other boundary is uneven, and the waveguide is filled with inhomogeneous, lossless fluid. The expansions accommodate the conditions that the pressure vanish at the flat boundary and that the normal component of fluid velocity vanish at the uneven boundary. The method of expansion is novel in that two essentially independent functions are expanded simultaneously.

84-2270

Noise of Air Jets from Rectangular Slits

L. Bjorno and P.N. Larsen

Technical Univ. of Denmark, Bldg. 352, DK-2800 Lyngby, Denmark, Acustica, 54 (5), pp 247-256 (Mar 1984) 9 figs, 16 refs

Key Words: Aerodynamic noise

A theoretical and experimental study of noise data arising from jets issued from rectangular slits with aspect ratio

between 33.3 and 100 is presented. The noise data; i.e., sound power levels, directivity patterns, and intensity spectra are experimentally determined as functions of flow and outlet factors like volumetric mean velocity of the slit flow, pressure drop across the slit and aspect ratio of the slit. Based on the noise data the existence of scaling laws is investigated.

84-2271

Measurement of Transmission Loss Characteristics Using Acoustic Intensity Techniques at the KU-FRL Acoustic Test Facility

J. Roskam

Univ. of Kansas, Lawrence, KS, Rept. No. KU-FRL-417-22, NASA-CR-173187, 125 pp (Dec 1983) N84-16942

Key Words: Sound transmission loss, Acoustic intensity method

The transmission loss characteristics of panels using the acoustic intensity technique is presented. The theoretical formulation, installation of hardware, modifications to the test facility, and development of computer programs and test procedures are described. A listing of all the programs is also provided. The initial test results indicate that the acoustic intensity technique is easily adapted to measure transmission loss characteristics of panels. Use of this method will give average transmission loss values.

84-2272

Simplified Combustion Noise Theory Yielding a Prediction of Fluctuating Pressure Level

R.G. Huff

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. E-1856, NASA-TP-2237, 17 pp (Feb 1984) N84-19049

Key Words: Combustion noise, Noise prediction, Turbine engines

The first order equations for the conservation of mass and momentum in differential form are combined for an ideal gas to yield a single second order partial differential equation in one dimension and time. Small perturbation analysis is applied. A Fourier transformation is performed that results in a second order, constant coefficient, nonhomogeneous equation. The driving function is taken to be the source of combustion noise. A simplified model describing the energy addition via the combustion process gives the required source information for substitution in the driving function. This enables the particular integral solution of the nonhomogeneous equation to be found. This solution multiplied by the acoustic pressure efficiency predicts the acoustic pressure spectrum measured in turbine engine combustors.

84-2273

Reducing the Primary Noise Originating in a Crankcase-Scavenged Two-Stroke Engine (Primäre Geräuschminderung an einem Zweitaktmotor mit Kurbelkammerspülung)

N. Kania

Institut f. Kolbenmaschinen, Universität Hannover, Welfengarten 1A, D-3000 Hannover 1, W. Germany, MTZ Motortech. Z., 45 (4), pp 137-143 (Apr 1984) 12 figs, 8 refs

(In German)

Key Words: Engine noise, Noise reduction

The dominant noise originating in small port-controlled two-stroke engines is caused by gas flow during the intake and exhaust phases. The quick opening and closing processes of the usually oval or rectangular control ports result in producing pressure pulses characterized by steep gradients, which excite the resonances of the gas-flow systems. Assuming that cross-section area and pressure curves are interrelated and based on the knowledge of the mechanism producing the noise, a reduction in noise can be achieved by changing the layout of the inlet- and outlet-port cross-section area without any loss in output. The cross-section area gradient existing during the early phase of the port-opening process has proved to be the design feature that is decisive in noise reduction. By comparing the calculated cross-section area gradients with the pressure gradients obtained from measurements, it is possible to estimate the actual noise excitation and reduction. A cross-section area opening gradient optimized with respect to noise and output can be stated for the engine examined.

84-2274

The Development of Sound Proofing Capsules and Cabins (Probleme bei der Entwicklung von Schallschutzkapseln und -kabinen)

M. Wiltzsch

Zentralinstitut f. Arbeitsschutz, Dresden, German Dem. Rep., Maschinenbautechnik, 33 (3), pp 106-110 (Mar 1984) 8 figs, 10 refs

(In German)

Key Words Noise reduction, Automobile noise, Enclosures

Various requirements which are to be considered in the design of sound proofing capsules and cabins are discussed. One important aspect is the directivity of capsules and the variable incident sound on the walls of the cabins. It is shown that low frequency components in cabins can be reduced by different means (e.g., by means of larger openings) than the medium or high frequency noises. The sealing of openings by means of fluid cold-curing two-component silicone rubber paste is described.

84-2275

Steady State Sound Field in an Enclosure with Diffusely and Specularly Reflecting Boundaries

K. Fujiwara

Institut f. Technische Akustik, RWTH Aachen, Acustica, 54 (5), pp 266-273 (Mar 1984) 7 figs, 3 tables, 7 refs

Key Words: Enclosures, Periodic response, Sound waves, Wave reflection

The effect of a specularly reflecting boundary portion on the steady state sound field in an enclosure with otherwise diffusely reflecting boundaries was studied by the use of the integral equation governing the sound field and the mirror image method. A two-dimensional rectangular enclosure was analyzed varying the distribution of the absorption coefficient, the source location and the location and length of the specularly reflecting boundary portion.

84-2276

Statistical Distribution of Free Pathlengths in the Acoustics of Enclosures

G. Benedetto and R. Spagnolo

Istituto Elettrotecnico Nazionale Galileo Ferraris, corso Massimo d'Azeglio 42, Torino, Italy, J. Acoust. Soc. Amer., 75 (5), pp 1519-1521 (May 1984) 4 figs, 7 refs

Key Words: Enclosures, Reverberation chambers, Acoustic absorption

In the acoustics of enclosures it is often necessary to know the probability density function of free pathlengths. Some applications are reported of Coleman's formula for the exact computation of the distribution and moments in ergodic regular enclosures. The results are compared with those obtained by computer ray-tracing simulation in the case of the specular reflection law. It is shown that the distribution is strictly connected to the shape of the enclosure.

84-2277

Utilization of Machinery Housing and Machinery Frame Vibration Sensitivity for Noise Reduction (Zur Beeinflussbarkeit des Schwingungsverhaltens von Maschinengehäusen und -gestellen zum Zweck der Geräuschminderung)

B.-G. Haustein and W. Schirmer

Zentral Institut f. Arbeitsschutz, Dresden, German Dem. Rep., Maschinenbautechnik, 33 (3), pp 115-119 (Mar 1984) 8 figs, 6 refs

(In German)

Key Words: Machinery noise, Noise reduction, Vibration control

Machinery noise generated by machinery vibration during operation can be reduced by controlling the vibration of machinery housings and frames. In the vibroacoustic mathematical model of mechanical noise generation the housing or frame is presented as a linear frequency-dependent transfer system. General vibroacoustic behavior of such structures and utilization for noise reduction can be determined by means of a model of plane homogenous plate. More detailed data is obtained by exciting such structures and measuring vibroacoustic transmission and point admittances

84-2278

Transfer Functions for Cam Gears Taking Acoustic Requirements into Consideration (Übertragungsfunktionen von Kurvengetrieben unter Berücksichtigung akustischer Forderungen)

K. Butter

VEB Textimaforschung Malimo, Karl-Marx-Stadt, Maschinenbautech., 33 (1), pp 35-38 (1984) 4 figs, 4 tables, 8 refs

(In German)

Key Words: Textile looms, Noise generation, Transfer functions

Noiseless transfer functions are represented for rest-in-rest and rest-in-reversal-motions. They are steady up to the third derivative. Some transfer functions are tested in a textile machine building and meet the demand for noiselessness.

SHOCK EXCITATION

84-2279

Shock Waves in Three-Dimensional Elastic Solids

T C T Ting

Dept. of Civil Engrg., Mechanics and Metallurgy, Univ. of Illinois at Chicago, Rept. No. ARO-17055.6-EG, 7 pp (Jan 1984)

AD-A138 018

Key Words: Shock waves, Wave propagation, Elastic media

Some aspects of shock waves in three-dimensional elastic solids are studied. In particular, the transport equations are derived for the growth or decay of a three-dimensional shock wave. This report summarizes the results obtained from this investigation.

84-2280

Experimental Investigation of Two-Dimensional Shock Boundary Layer Interactions

S.A. Skebe

Ph.D. Thesis, Case Western Reserve Univ., 786 pp (1983)

DA8405256

Key Words: Shock waves, Plates, Wind tunnel testing

Experiments were performed on the interaction of oblique shock waves with flat plate boundary layers. Measurements of the plate surface static pressure and shear stress distributions as well as boundary layer velocity profiles were obtained through the interaction region. The findings provide a complete description of two-dimensional interactions with initially laminar boundary layers over the Mach number range 2.0 to 4.0. Additional information with regard to interactions involving initially transitional boundary layers is provided over the Mach number range 2.0 to 3.0 and those for initially turbulent boundary layers at Mach 2.0.

84-2281

On the Radiation of Elastic Waves

N. Selskaja

Moskovskii Inzhenerno-Stroitelnii Institute, Moscow, USSR, Dynamics and Strength of Machinery and Structures, 25th Proc. in Mechanics, Vilnius Civil Engrg. Inst., Vilnius, Lithuanian SSR, 1983, pp 84-96, 4 figs, 10 refs

(In Russian)

Key Words: Elastic waves, Wave propagation, Shock waves

An explosive charge detonated in a spherical vacuum within an isotropic mountainous rock generates gas at some initial pressure. After detonation the vacuum expands according to the adiabatical law. The effect of the parameters of the medium and the size of the plastic region on the propagation of elastic waves is investigated. The author examines applicability of the linear theory to the investigation of elastic wave motion.

84-2282

Impact-Tension Compression Test by Using a Split-Hopkinson Bar

K. Ogawa

Univ. of Maryland, College Park, MD 20742, Exptl. Mech., 24 (2), pp 81-86 (June 1984) 7 figs, 8 refs

Key Words: Impact tests, Testing techniques

A new impact-tension-compression testing technique based on a one-dimensional elastic-stress-wave theory has been developed. The technique was applied to investigate dynamic response in pure iron. The experimental results of the loading wave agreed well with the theoretical prediction. The stress, strain, and strain rate of a specimen during impact were evaluated with the aid of a stress-wave analysis.

84-2283

Seismic Soil-Structure Interaction by the Superposition Method

A. Gomez-Masso

Consulting Engineer, Berliner Str. 290, 6050 Offenbach/Main, Fed. Rep. Germany, Nucl. Engrg. Des., 78 (1), pp 37-52 (Mar 1984) 17 figs, 3 tables, 18 refs

Key Words: Interaction: soil-structure, Seismic analysis, Method of superposition

The superposition technique is a simple yet powerful method for soil-structure seismic interaction problems. The method essentially consists of obtaining total motions by superposing free field motions and interaction motions, both previously calculated in separate analyses. The method is explained in detail, and three case studies are also summarized as an illustration of the flexibility of the method.

84-2284

Structural Response under Multicomponent Earthquakes

M.P. Singh and M. Ghafory-Ashtiany

Dept. of Engrg. Sci. and Mechanics, Virginia Polytechnic Inst., Blacksburg, VA, ASCE J. Engrg. Mech., 110 (5), pp 761-775 (May 1984) 5 figs, 17 refs

Key Words: Seismic response

Earthquake motions as felt by structures along three orthogonal directions are statistically correlated. The effect of this correlation on structural response is studied.

84-2285

Seismic Inputs for Nonlinear Structures

A.J. Philippacopoulos and P.C. Wang

Brookhaven National Lab., Civil Engrg., City Univ. of New York, NY, ASCE J. Engrg. Mech., 110 (5), pp 828-836 (May 1984) 3 figs 1 table, 26 refs

Key Words: Seismic response, Nonlinear theories

Some seismic inputs that may be used for nonlinear structures are presented. They are generated from recorded earthquakes and produce maximum nonlinear response.

84-2286

Food Store Disturbance as a Seismic Intensity Indicator

R. Nason

U.S. Geological Survey, 345 Middlefield Rd., Menlo Park, CA 94025, Bull. Seismological Soc. Amer., 74 (3), pp 987-993 (June 1984) 1 fig, 1 table, 11 refs

Key Words: Seismic response, Buildings

The disturbance of shelf items in food stores as a useful system for the reliable determination of seismic intensity is discussed. Observations indicate that the food store disturbances are comparable to the Modified Mercalli intensity scale from less than intensity V to greater than intensity VII. The food store seismic intensity correlates well with the measurements of peak acceleration on nearby strong-motion instruments.

84-2287

Parkes Revisited: On Rigid-Plastic and Elastic-Plastic Dynamic Structural Analysis

P.S. Symonds and W.T. Fleming, Jr.

Brown Univ., Providence, RI 02912, Intl. J. Impact Engrg., 2 (1), pp 1-36 (1984) 12 figs, 7 tables, 10 refs

Key Words: Pulse excitation, Mass-beam systems

A classical problem of rigid-plastic structural dynamics solved by Parkes is re-examined; namely, that of finding the deformations of a beam carrying a mass at its tip which is subjected to a short pulse loading. Parkes introduced a correction for effects of high strain rates shown to be needed by his experiments on steel beams. The neglect of elastic strains -- elastic moduli taken infinite -- is a crucial assumption, and its validity is the subject of this paper. It is studied by making comparisons between exact numerical solutions furnished by an advanced finite element computer program for an elastic-plastic beam, and the rigid-plastic solution slightly modified to allow for large deflections.

VIBRATION EXCITATION

84-2288

Coupled Flutter and Divergence Bifurcation of a Double Pendulum

R. Scheidl, H. Troger, and K. Zeman

Institut f. Mechanik, TU-Wien, A-1040 Vienna, Karlsplatz 13, Austria, Intl. J. Nonlin. Mech., 19 (2), pp 163-176 (1984) 11 figs, 22 refs

Key Words: Pendulums, Flutter

The loss of stability of the equilibrium position of a double pendulum with follower force loading and elastic end support is studied. At a special parameter combination the linearized system is characterized by a zero root and a pure imaginary pair of eigenvalues. Therefore, the stability problem is a complicated critical case in the sense of Liapunov and requires a nonlinear analysis. A complete post-bifurcation investigation of the coupled divergence and flutter motions is given by means of center manifold theory and bifurcation diagrams.

84-2289

The Response of Nonlinear Structures to Random Excitation

C.W.S. To

The Univ. of Calgary, Calgary, Alberta, Canada T2N 1N4, Shock Vib. Dig., 16 (4), pp 13-33 (Apr 1984) 2 figs, 143 refs

Key Words: Random excitation, Nonlinear systems, Reviews

This paper provides an update of the state of the art techniques used for the analysis of general nonlinear mechanical systems to random excitation. Special attention is paid to methods applied to multi-degree-of-freedom nonlinear systems subjected to nonstationary random excitation. Their suitability and adaptability to finite element analysis of complicated nonlinear structures with large deformation and finite strain are also assessed. Conclusions are drawn and a recommendation for future studies is given.

84-2290

The Cause and Cure of Press Section Vibrations

J Anema and B. Clarke

Paper Machinery Div., Beloit Corp., Beloit, WI 53511, TAPPI J. 67 (3), pp 58-61 (Mar 1984) 4 figs

Key Words: Paper products, Machinery, Machinery vibration

Vibration problems occurring in the press section can be very difficult to classify and resolve. Some of the equipment used to measure vibrations is reviewed. Structural and component vibrations are defined, and some techniques for minimizing them are described. Nip bounce vibration is also defined, and some developments for controlling it are explained. Finally, some miscellaneous sources of vibration are discussed, along with techniques for identifying and resolving them.

MECHANICAL PROPERTIES

DAMPING

(Also see No. 2185)

84-2291

A Method for the Analysis of Vibrating Systems Subjected to Random Excitation

M. DiPaola

Facolta di Ingegneria, Istituto di Scienza delle Costruzioni, V. le delle Scienze, 90128, Palermo, Meccanica, 19 (1), pp 61-67 (Mar 1984) 6 figs, 9 refs

Key Words: Damped structures, Random excitation

A general method is developed to evaluate the nonstationary response of a linear damped system subjected to a random excitation which is represented as the product of a modulating deterministic function and a white noise process. An approximate solution method is presented first by means of a step-by-step procedure; then this method is shown to be able to generate a differential equation for the time variation of the mean square response. Stability and accuracy of the step-by-step procedure are discussed in detail, and compared with other methods. Extension to multidegree of freedom and nonlinear systems are discussed.

84-2292

Design Study of Magnetic Eddy-Current Vibration Suppression Dampers for Application to Cryogenic Turbomachinery

E.J. Gunter, R.R. Humphris, and S.J. Severson

Univ. of Virginia, Charlottesville, VA, Rept. No. UVA-52810/MAE84/101, NASA-CR-173273, 142 pp *(Dec 1983)*

N84-16562

Key Words: Magnetic damping, Turbomachinery

Cryogenic turbomachinery used to pump high pressure fuel (liquid H2) and oxidizer (liquid O2) to the main engines of the space shuttle have experienced rotor instabilities. Subsynchronous whirl, an extremely destructive instability, has caused bearing failures and severe rubs in the seals. These failures have resulted in premature engine shutdowns or, in many instances, have limited the power level to which the turbopumps could be operated. The feasibility of using an eddy current type of damping mechanism for the space shuttle main engine is outlined.

84-2293

Vibration Control with Viscoelastic Materials -- III

B.C. Nakra

Indian Inst. of Tech., New Delhi-110016, India, Shock Vib. Dig., 16 (5), pp 17-22 (May 1984) 78 refs

Key Words: Damping, Viscoelastic damping, Layered materials, Reviews

This paper reviews work on the analysis of layered structures in which layers of viscoelastic materials are used for damping, work on the use of discrete dampers, work on properties of viscoelastic materials, and engineering applications of techniques employing viscoelastic materials for vibration damping.

FATIGUE

84-2294

Numerical Evaluation of the Growth Rate Material Parameters in Fatigue Propagation of Surface Flaws

C. Manu and A.R. Ingraffea

Canada Systems Group, Multiple Access Div., Don Mills, Ontario Canada M3C 3H1, Nucl. Engrg. Des., 77 (2), pp 131-138 (Feb 1984) 6 figs, 3 tables, 16 refs

Key Words: Fatigue life, Crack propagation

Fatigue propagation of a surface flaw in a plate was studied using the Paris model. A large variation was obtained for the coefficient of the Paris model along the crack front when the classical technique was used. A new technique, which gives a fairly constant value for this coefficient, was evaluated and discussed.

84-2295

Fatigue Damage: Mechanics of Carbon-Fibre Reinforced Laminates

A. Poursartip, M.F. Ashby, and P.W.R. Beaumont

Cambridge Univ., UK, Rept. No. CUED/C/MATS/TR-101, 66 pp (Dec 1983)

PB84-170133

Key Words: Fatigue life, Layered materials, Fiber composites

A quantitative empirical approach to the fatigue behavior of composites is described. The authors introduce a damage model which proposes that, if physical damage changes the moduli of the material, then by monitoring these moduli during fatigue loading, damage growth can be measured. If, further, a critical or terminal damage can be defined, then the moduli allow the residual life to be calculated. The approach is applied to a CFC quasi-isotropic system in tension-tension fatigue.

ELASTICITY AND PLASTICITY

(Also see No. 2248)

84-2296

Surface Integral Finite Element Hybrid (SIFEH) Method for Fracture Mechanics

B.S. Annigeri and M.P. Cleary

Massachusetts Inst. of Tech., Cambridge, MA, Intl. J. Numer. Methods Engrg., 20 (5), pp 869-885 (May 1984) 15 figs, 5 tables, 35 refs

Key Words: Finite element technique, Fracture properties, Computer programs

An effective surface integral and finite element hybrid (SIFEH) method has been developed to model fracture problems in finite plane domains. This hybridization by (incrementally) linear superposition combines the best features of both component methods. This method has been implemented in a computer program and results of representative problems are presented.

84-2297

A Dynamic Fracture Assessment of Impact Damage in Structural Ceramics

B.-M.B. Liaw

Ph.D. Thesis, Univ. of Washington, 160 pp (1983) DA8404924

Key Words: Ceramics, Fracture properties

The first part of this dissertation deals with dynamic fracture characterizations of glass and RBSN at room temperature and under static loading. In the second part of this study, a mechanistically consistent damage model, which is based on elastic failure at tensile and shear overloads, is used to construct a phenomenological, finite element model of impact damage of ceramics at room temperature.

84-2298

Finite-Element Analysis of Lamb Wave Scattering in an Elastic Plate Waveguide

M. Koshiba, S. Karakida, and M. Suzuki

Hokkaido Univ., Sapporo, 060, Japan, Sonics Ultrasonics, IEEE Trans., SU-31 (1), pp 18-24 (Jan 1984) 8 figs, 16 refs

Key Words: Waveguide analysis, Elastic waves, Wave scattering, Finite element technique

A method of solution of scattering of the fundamental symmetric Lamb wave in an elastic plaste waveguide is described. The approach is a combination of the finite-element and analytical methods. The numerical examples on the scattering by a wedge-shaped internal crack and a wedge-shaped surface crack in a plate are given.

84-2299

An Experimental Investigation on Isoclinic Parameters in Viscoelastoplastic Materials under Cyclic Stresses

H. Tobushi, Y. Narumi, Y. Ohashi, and W. Nakane
Aichi Inst. of Tech., 1247 Yachigusa, Yagusa-cho, Toyota 470-03, Japan, Exptl. Mech., 24 (2), pp 87-92 (June 1984) 5 figs, 16 refs

Key Words: Viscoelastic media, Cyclic loading

The behavior of isoclinic parameters were examined experimentally under cyclic stressing where the direction of principal stress changes alternately. The variation of isoclinic parameters in relation to the number of cycles was measured together with the corresponding strain state on the thin-walled tubular specimen of celluloid softened by heating, subjected to combined loading conditions consisting of constant axial tension and cyclic torsion.

WAVE PROPAGATION

84-2300

Rayleigh Wave Transmission Reciprocity Past a Step Change in Elevation

J.R. Chamuel
The Charles Stark Draper Lab., Inc., Cambridge, MA 02139, J. Acoust. Soc. Amer., 75 (5), pp 1491-1494 (May 1984) 4 figs, 2 tables, 15 refs

Key Words: Wave propagation, Rayleigh waves

Contradicting experimental, approximate theoretical, and numerical results have been reported on Rayleigh wave transmission coefficient past a step change in elevation. In this paper, reciprocity for wave propagation in both directions across a step is demonstrated experimentally using a new ratio technique eliminating error sources introduced from elastic wave generation, coupling, and detection. Two-dimensional ultrasonic models were used to obtain the data. The ratio of step height to Rayleigh wavelength tested ranged from 0.159 to 1.33.

84-2301

Finite Difference Analysis of Rayleigh Wave Transmission Past an Upward Step Change

M. Fuyuki and M. Nakano
Kansai Univ., Suita, Osaka 564, Japan, Bull. Seismological Soc. Amer., 74 (3), pp 893-911 (June 1984) 11 figs, 20 refs

Key Words: Rayleigh waves, Wave transmission

Transmission coefficients of the Rayleigh wave past an upward step change are obtained by the finite difference scheme. In the region of large height of a step relative to a wavelength h/λ, individual phases of the transmitted wave are investigated and the dominant wave in each phase is clarified.

84-2302

Elastic Wave Calculations by the Fourier Method

D. Kosloff, M. Reshef, and D. Loewenthal
Tel-Aviv Univ., Ramat Aviv, 69 978 Tel-Aviv, Israel, Bull. Seismological Soc. Amer., 74 (3), pp 875-891 (June 1984) 9 figs, 6 refs

Key Words: Wave propagation, Elastic waves, Fourier analysis

A two-dimensional forward modeling algorithm based on a Fourier method is introduced. In order to be able to handle the free surface boundary condition with the Fourier method, a new set of wave equations are derived which contain the stresses as unknowns instead of the displacements. The solution algorithm includes a discretization in both space and time. Spatial derivatives are approximated with the use of the Fast Fourier Transform, whereas temporal derivatives are calculated with second order differencing. The numerical method is tested against the analytic solution for Lamb's problem in two dimensions.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

(Also see Nos. 2352, 2368)

84-2303

A Coordinate Reduction Technique for Dynamic Analysis of Spatial Substructures with Large Angular Rotations

A.A. Shabana and R.A. Wehage
Univ. of Illinois at Chicago, Chicago, IL 60680,
J. Struc. Mech., 11 (3), pp 401-431 (1983) 7 figs, 36 refs

Key Words: Substructuring methods

A substructuring technique is presented for transient dynamic analysis of systems composed of interconnected rigid and elastic bodies that undergo large angular displacements. Displacement of elastic bodies is represented by superposition of local linear elastic deformation on large displacement of body reference coordinate systems. Elastic bodies are thus represented by combined sets of reference and local elastic generalized coordinates. Planar and spatial linkages with flexible elements are presented to illustrate use of the method developed.

84-2304

Modal Resolution of Transient Vibrations in Rotor-Bearing-Foundation Systems Caused by Electrical System Faults

T. Jainski
Technical University Berlin, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 177-189, 9 figs, 7 refs

Key Words: Interaction: rotor-foundation, Transient response, Component mode analysis, Modal superposition method

For the dynamic analysis of many rotating structures it is necessary to take into account the dynamic behavior of their foundations. The discretization of rotor-bearing-foundation systems by finite element models produces a very high number of degrees of freedom whereas a limited number of eigenvibrations would be sufficient for technical purposes to determine the system response. The component mode method is employed to reduce the number of mathematical unknowns and the reduced set of non-conservative equations of motion are separated by binormal orthogonalization in order to represent system response by the mode-superposition procedure.

84-2305

Uncertainty Principle in Frequency-Time Methods

Y.H. Tsao
Intercole Systems Limited, Avenger Close, Chandlers Ford, Eastleigh Hants, S05 3YU, UK, J. Acoust. Soc. Amer., 75 (5), pp 1532-1540 (May 1984) 2 tables, 50 refs

Key Words: Stochastic processes, Time dependent parameters, Spectrum analysis

Stochastic process theory has recently been extended to the nonstationary case and the concepts extended to include the time-varying parameters such as evolutionary spectra. Previous papers have reviewed and concluded that despite the time variation underlined, the evolutionary spectral density function may still be estimated or measured for numerous nonstationary processes. One of the most important aspects of the practical estimates is closely related to their accuracy which is now defined in both the frequency and time dimensions. In this paper the limit of the two resolutions for the common evolutionary spectral estimators is discussed and the obvious tradeoff relationship between the two is explained in the context of the popular filter/window techniques.

84-2306

Modal Parameter Identification and Sensitivity Analysis in Rotating Machinery

R. Nordmann
Dept. of Mech. Engrg., Univ. of Kaiserslautern, Fed. Rep. Germany, Rotordynamics Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 95-102, 18 figs, 2 refs

Key Words: Modal analysis, Parameter identification technique, Rotating machinery, Sensitivity analysis

A valuation of the dynamic behavior of rotating machinery is possible by means of the modal parameters (eigenvalues and nautral modes). To identify these quantities a combined

experimental and analytical method is described. A sensitivity analysis is also represented, pointing out the influence of parameter changes on the dynamics of rotors. An application is given for a test rig rotor in journal bearings.

84-2307

The Modal Survey of the Galileo Spacecraft

R.C. Stroud

Synergistic Technology Inc., Cupertino, CA, S/V, Shock Vib., 18 (4), pp 28-34 (Apr 1984) 12 figs, 2 tables, 21 refs

Key Words: Modal analysis, Spacecraft

The Jet Propulsion Laboratory performed the Galileo Spacecraft Modal Survey in Pasadena, California during June and July 1983. A thorough testing program was conducted to identify the spacecraft's significant modes and verify its analytical model. A variety of excitation functions and analysis techniques were used to identify and characterize the target modes which were selected on the basis of a finite-element pretest analysis.

84-2308

Impedance Methods for Machine Analysis: Modal Parameters Extraction Techniques

M. Massoud

Universite de Sherbrooke, Sherbrooke, Quebec, Canada, Shock Vib. Dig., 16 (5), pp 5-14 (May 1984) 4 figs, 41 refs

Key Words: Parameter identification technique, Modal analysis, Impedance technique, Frequency domain method, Machinery, Reviews

Earlier papers reviewed basic definitions, mathematical background, and a broad spectrum of industrial applications of impedance methods. These methods are based on the analysis of frequency response measurements between relevant points on machine structures. The advent of practical and affordable microprocessor-based systems has given rise to algorithms for the precise extraction of modal parameters from frequency response measurements and the subsequent estimation of physical parameters of machine structures. This paper reviews recent advances in the algorithms.

84-2309

Experimental/Analytical Determination of the Real Normal Mode Parameters of a Structure with Limited Accessibility

N. Niedbal

Deutsche Forschungs- und Versuchsanstalt fuer Luft und Raumfahrt e.V., Goettingen, Fed. Rep. Germany, Rept. No. DFVLR-FB-83-26, 129 pp (Apr 1983) (to be announced as translation Esa-T 839) N84-18711

(In German)

Key Words: Experimental modal analysis, Parameter identification technique, Phase separation method

Phase separation methods for the experimental determination of normal mode parameters are proposed. As opposed to the classical phase resonance method, these methods require no adjustment of the exciter forces. In the case of a structure with limited accessibility, such methods improve the experimental modal analysis. A phase separation method is selected and its reliability enhanced for the case of damping coupling. A method to transform complex normal mode parameters into real normal ones is presented.

84-2310

Component Mode Synthesis and Large Deflection Vibrations of Complex Structures

C. Mei

Old Dominion Univ., Norfolk, VA, Rept. No. NASA-CR-173338, 16 pp (Feb 1984) N84-18680

Key Words: Modal synthesis, Component mode synthesis, Beams, Finite element technique, Harmonic excitation, Computer programs

The accuracy of the NASTRAN modal synthesis analysis was assessed by comparing it with full structure NASTRAN and nine other modal synthesis results using a nine-bay truss. A NASTRAN component mode transient response analysis was also performed on the free-free truss structure. A finite element method was developed for nonlinear vibration of beam structures subjected to harmonic excitation. Longitudinal deformation and inertia are both included in the formula.

84-2311

Modal Deformations and Stresses

P. Lacoste

Engineering System International, Rungis, France, Rept. No. ED-81-343/RD, ESA-CR(P)-1777, 94 pp (Jan 1983)
N84-18712

Key Words: Modal synthesis, Lagrange equations

The fixed, free and loaded modal synthesis interface methods, and the general Lagrangian reduction methods were reviewed, using a uniform beam example. The free interface method always provides the least accurate results. The loaded interface method is best for the first elastic modes. Fixed interface method accuracy is comparable to the loaded interface method. The fixed interface method permits a completely separate analysis of each substructure and may be more appropriate for industrial applications.

84-2312

Quasi-Modal Nonlinear Analysis for Seismic Response in Pump Rotors

M. Kaga, K. Kikuchi, O. Matsushita, M. Takagi, and M. Furudono
Mech. Engrg. Res. Lab., Hitachi Ltd., Japan, Rotordynamic Problems in Power Plants Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 83-93, 18 figs, 2 tables, 8 refs

Key Words: Rotors, Pumps, Seismic response, Nonlinear theories, Quasi-modal analysis

A new transformation is defined by a matrix that includes eigenvector ϕ for an inner coordinate system, static deflection mode δ under the condition of a forced unity displacement and dynamic deflection mode ξ under a forced unity velocity. The proposed transformation is very close to a modal transformation or the so-called quasi-modal technique. In order to verify the validity of the new analytical method, an exciting test is done on a large scale laboratory system employing a model pump rotor. The values calculated with this program using quasi-modal analysis are in good agreement with the measured ones.

84-2313

Frequency Domain Approach to Structural Analysis

H.J. Weaver
Lawrence Livermore National Lab., CA, Rept. No. UCID-19950, 46 pp (Mar 1, 1983)
DE84005110

Key Words: Forced vibration, Frequency domain method

To conduct a forced vibration analysis, a mathematical model of the structure is first constructed. In this case, a single degree of freedom model is assumed. Solution of the model in the time domain using the impulse response and the fast Fourier transform methods are briefly described prior to introducing the frequency domain approach. The solution in the frequency domain, involving the eigenfunctions and transfer functions of the system, is then performed. The relationship between the time and frequency domain solutions is discussed, and the transfer function of a general structure is derived.

84-2314

New Method of Measuring Vibration Amplitudes of Quartz Crystals

L. Wimmer, S.Hertl, J. Hemetsberger, and E. Benes
Institut f. Allgemeine Physik, Technische Universitat Wien, Karlsplatz 13, A-1040 Vienna, Austria, Rev. Scientific Instrum., 55 (4), pp 605-609 (Apr 1984) 12 figs, 21 refs

Key Words: Quartz crystals, Amplitude measurement

A new method is presented to measure in-plane vibration amplitudes of the order of some 10 nm. The measurement system utilizes the speckler effect and consists of only a few mechanical components. The evaluation is done by a microcomputer. The whole system is insensitive to environmental noise. The method has been applied to investigate the amplitude distribution of plano-convex AT-cut quartz crystals as they are commonly used in thin-film thickness monitors.

84-2315

Real-Time Uses for Microcomputers: Data Acquisition and Analysis

M.S. Darlow
Rensselaer Polytechnic Inst., Troy, NY, Computers Mech. Engrg., 2 (5), pp 57-61 (Mar 1984) 4 figs, 14 refs

Key Words: Microcomputers, Real time technique

The configuration and possible applications of a simple but powerful microcomputer-based data acquisition and analysis system are discussed.

84-2316

Application of the Microprocessor System MPS 4944 for the Analysis of Burst-Signals of the Sound Emission (Anwendung des Mikroprozessorsystems MPS 4944 zur Analyse der Burst-Signale der Schallemission)

G. Kirchhoff, H. Six, and A. Lamsa

Feingeratetechnik, 33 (3), pp 128-141 (1984) 7 figs, 4 refs

(In German)

Key Words: Acoustic emission, Measuring instruments

A microcomputer-assisted measuring system for the data acquisition and processing for the sound emission analysis is presented. The operation mode is described and essential parts of the software are explained.

84-2317

Model Considerations Concerning the Dynamic Behaviour of Animal Scales (Modellbetrachtungen zum dynamischen Verhalten von Tierwaagen)

C. Lankow

Forschungszentrum f. Tierproduktion der Akademie der Landwirtschaftswissenschaften der DDR, Dummerstorf-Rostock, Feingeratetechnik, 33 (3), pp 108-112 (1984) 6 figs, 11 refs

(In German)

Key Words: Weighing systems, Measuring instruments, Mathematical models, Vibration response

A vibration model is necessary for the calculation of the reaction of a weighing system on the input quantity animal force. For model considerations a calculation model with three degrees of freedom results. The dynamic behavior of the whole system was mathematically described by motion equations from the force equilibrium at the joining points of the single masses.

84-2318

Hand-Held Digital Sonic Pile-Testing System

G.G. Coghill and H.W. Whittington

Univ. of Edinburgh, The King's Bldg., Edinburgh EH9 3JL, UK, J. Phys. E: Sci. Instrum., 17 (6), pp 462-465 (June 1984) 3 figs, 4 refs

Key Words: Measuring instruments, Diagnostic techniques, Pile structures, Pile foundations

There are many applications where real-time data acquisition is necessary but where signal processing can be done off-line. This paper describes the design, fabrication and testing of a unit which can be used to capture and store information from nondestructive testing of up to 40 concrete cast in situ piles. Major features are the hand-held size of the unit and the use of a programmable gain amplifier to cope with temporal changes in signal strength.

84-2319

Measurement of the Transfer Function of Seismic Channels

J. Rasson and F. DeMeyer

Centre de Physique du Globe de L'IRM, B-6381 Dourbes, Belgique, J. Phys. E: Sci. Instrum., 17 (5), pp 394-397 (May 1984) 5 figs, 8 refs

Key Words: Transfer functions, Measurement techniques

A rapid and accurate method is presented for measuring the transfer function of seismic channels by using the step-excitation technique. The parameters of the Laplace polynomials are estimated by inverting the step response of the channel. Special attention is paid to the estimation of reliable confidence bands: the statistical structure of the observed residuals is taken into account. An example is given for S-5007 long-period instruments coupled to four-order bandpass filters.

84-2320

***Photometric Measurements* -- *Suitability* of Different Photoelectric Sensors and Some Techniques to Acquire Data in Static and Dynamic Photoelasticity**

V.G. Idichandy, G. Venkata Rao, and G. Thomas

Ocean Engrg. Centre, Indian Inst. of Tech., Madras, Italy, J. Phys. E: Sci. Instrum., 17 (6), pp 466-471 (June 1984) 7 figs, 15 refs

Key Words: Photoelastic analysis, Measurement techniques

To find the suitability of different photoelectric sensors for possible use in static and dynamic photoelasticity, the performance characteristics of these sensors were evaluated using the polarized as variable attenuators. The selected sensors and signal conditioners were then used in measurements involving static photoelasticity. These measurements

can be used to eliminate operator errors from photoelastic data. The use of light intensity sensors for acquiring data in dynamic photoelasticity is explained and a new technique to count the fringes in an optically nondiscriminatory, dynamic-photoelastic oscillogram is introduced.

84-2321

Magnetostriction Harmonics Measurement Using a Double Piezoelectric Transducer Technique

D.J. Mapps and C.E. White

Dept. of Electrical Engrg., Plymouth Polytechnic, Drake Circus, Plymouth, Devon PL4 8AA, UK, J. Phys. E: Sci. Instrum., 17 (6), pp 472-476 (June 1984) 7 figs, 16 refs

Key Words: Magnetically induced vibrations, Measurement techniques, Vibration measurement

The measurement of magnetostriction by the double-transducer technique has advantages of flexibility and sensitivity but is limited by sensitivity variations and phase shifts between transducers. This paper analyzes technique limitations and shows how they can be overcome in a practical measurement of magnetostriction harmonics. The apparatus is sufficiently accurate to resolve a relative movement of 2 nm with a base noise level equivalent to 0.5 nm.

DYNAMIC TESTS

84-2322

How to Design Stingers for Vibration Testing of Structures

L.D. Mitchell and K.B. Elliott

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, S/V, Sound Vib., 18 (4), pp 14-18 (Apr 1984) 3 figs, 5 refs

Key Words: Test equipment and instrumentation, Shakers, Vibration tests, Mobility method, Stingers

An approximate method for designing the interconnection of a mobility test shaker to a dynamic test structure is presented. A systematic procedure is presented for the selection of stinger flexural stiffness and shaker support stiffness to reduce the influence of shaker inertia on modal data to be collected. An example of the misuse of stingers and correction of the design is included.

84-2323

Certification Vibration Tests, SD802 Materials Experiment

A.F. DiGiacomo, W.C. Burns, and P. Schall

Aerospace Corp., El Segundo, CA, Rept. No. TR-0084(4935-05)-2, SD-TR-83-87, 136 pp (Dec 15, 1983)

AD-A138 547

Key Words: Vibration tests, Spacecraft

The SD802 materials experiment has been subjected to a certification vibration test as a space transportation system flight safety completion requirement. The test described within this report verifies the structural integrity and demonstrates the ability to satisfy functional requirements of the experiment. The final flight weight and center of gravity of each experiment tray are also determined.

84-2324

Laser Velocimeter System for Large-Scale Aerodynamic Testing

M.S. Reinath, K.L. Orloff, and P.K. Snyder

NASA Ames Res. Ctr., Moffett Field, CA, Rept. No. A-9524, NASA-TM-84393, 31 pp (Jan 1984)

N84-16144

Key Words: Test facilities, Aerodynamic loads

A unique laser velocimeter was developed that is capable of sensing two orthogonal velocity components from a variable remote distance of 2.6 to 10 m for use in 40- by 80-foot and 80- by 120-foot wind tunnels and an outdoor aerodynamic research facility. The system hardware, positioning instrumentation, and data acquisition equipment are described in detail; system capabilities and limitations are discussed; and expressions for systematic and statistical accuracy are developed. Direct and coupled laboratory measurements taken with the system are compared with measurements taken with a laser velocimeter of higher spatial resolution.

84-2325

A Modified Instrumented Charpy Test for Cement-Based Composites

V.S. Gopalaratnam, S.P. Shah, and R. John

Northwestern Univ., Evanston, IL 60201, Exptl Mech., 24 (2), pp 102-111 (June 1984) 9 figs, 1 table, 18 refs

Key Words: Testing techniques, Impact tests, Composites

A description is given of a modified instrumented Charpy test that is designed to enable impact-testing of cement-based composites. Problems encountered in instrumented impact testing of such composites and solutions to overcome them are discussed. Results of tests on concrete specimens at four different impact velocities are reported and are used to evaluate the performance of the test setup.

84-2326

Development of an Impact Exciter for Large Structure and Results of a First Application

K. Schöllhorn

Technische Hochschule Darmstad, Fed. Rep. Germany, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 163-175, 14 figs, 5 refs

Key Words: Testing instrumentation, Impact excitation

The development and details of design of a pneumatically driven impact exciter and its first application are described. Typical applications are vibration investigations into large structures such as foundations, large housings, buildings, etc. By using this exciter type, it is fairly easy to take advantage of the impact method. The first prototype proved itself in a vibration investigation into the large concrete foundation of a power plant. During this investigation the modal parameters (mode shapes, natural frequencies and modal damping) were determined. Some typical results are presented.

84-2327

Road Simulator and the Digital Oscilloscope Used for Fatigue Tests

A. Tegen

Nicolet Instrument Corp., Madison, WI, Exptl. Tech., 8 (5), pp 34-37 (May 1984) 8 figs

Key Words: Automobiles, Fatigue tests, Ride dynamics

A unique three-dimensional fatigue-testing system is described which has improved the testing of complex front-end-suspension and steering systems. It has brought results in a fraction of the time formerly needed for road tests, enabling design engineers to make improvements in components more quickly and with more reliability. The digital oscilloscope has helped to speed testing, and has provided reliable and accurate data in almost every phase of fatigue and shock testing.

84-2328

Digital Oscilloscope Simplifies Shock Tests

S/V, Sound Vib., 18 (4), pp 6, 8, 10 (Apr 1984) 6 figs

Key Words: Shock tests, Oscilloscopes, Computer-aided techniques

A procedure for interfacing a digital oscilloscope with a computer for shock testing is described. By this procedure the shock test can now be finished within one day.

SCALING AND MODELING

84-2329

Experimental Verification of Scaling Laws for Punch-Impact-Loaded Structures

T.A. Duffey, M.C. Cheresh, and S.H. Sutherland

P.O. Box 4404, Albuquerque, NM 87196, Intl. J. Impact Engrg., 2 (1), pp 103-117 (1984) 8 figs, 1 table, 11 refs

Key Words: Scaling, Impact response

Scaling laws are developed for the punch-impact response of structures, including elastic-plastic effects and ductile failure. The scaling laws are validated by a set of half- and full-size punch experiments performed on mild- and stainless-steel plates. Full- and half-scale agreement is generally within ten percent, with deflections somewhat larger and energy absorbed somewhat smaller for the full-scale prototype when compared with the respective values for the one-half-scale model. An approximate energy analysis is included which provides estimates of plate central deflections up to the point of through-punching.

DIAGNOSTICS

84-2330

Analysis of Reciprocating Compressor Piston Rod Failure

H.A. Tripp and M.J. Drosjack

Shell Development Co., Houston, TX, ASME Paper No. 84-Pet-30

Key Words: Diagnostic techniques, Reciprocating compressors

This report presents the analysis of five piston rod failures that occurred on reciprocating compressors. Calculations are shown for rod stress that include nominal rod loading sources as well as additional loads due to unusual pressure losses in the compressor valves, flexure of the rods due to misalignment, and manufacturing errors. The calculation procedures are described in a manner that will permit their application to other reciprocating compressors.

84-2331

Crankshaft Bearings: Advances in Predictive Techniques and Measurements in Engines

J.M. Conway-Jones, G.J. Jones, and M. Kendrick Glacier Metal Co., Ltd., Wembley, England, ASME Paper No. 84-DGP-4

Key Words: Diagnostic techniques, Bearings, Crankshafts

Measurements of oil film pressure and journal displacement in engine tests are reported. The results indicate that the deflections of crankshaft and bearing housings have a significant effect on bearing behavior. The implications for current and possible future predictive programs are discussed.

84-2332

Analysis of Turbogenerator Operation Defects on the Basis of Their Vibratory Behaviour

A. Benanti, C. Frigeri, A. Macchi, T. Rossini, and M. Marinelli

ENEL-DCO, Rome, Italy, Rotordynamic Problems in Power Plants Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 17-26, 11 figs, 4 refs

Key Words: Diagnostic instrumentation, Turbogenerators, Proximity probes, Rotors

The paper summarizes the results obtained from a study performed for the definition of an analysis of turbogenerator operation defects detected on the basis of their vibratory behavior. The analyses developed make use of eddy-current proximity transducers to measure vibrations and a transducer to measure the pressure of the oil film at the lower central part of the bearing. To check the shaft vertical alignment, use is made of the differential electronic altimeter system. The main advantage offered by this system is the possibility of measuring the vertical alignment during operation of the turbogenerator.

84-2333

Innovative Concepts for Detecting and Locating Leaks in Waste Impoundment Liner Systems: Acoustic Emission Monitoring and Time Domain Reflectometry

J.L. Davis, R. Singh, B.G. Stegman, and M.J. Waller Earth Tech Res. Corp., Baltimore, MD, Rept. No. EPA-600/2-84-058, 105 pp (Feb 1984) PB84-161819

Key Words: Failure detection, Acoustic emission, Time domain method

This project is part of a program to investigate the use of innovative techniques for detecting and locating leaks in waste impoundment liners. Laboratory and small scale field studies were undertaken to evaluate the potential of acoustic emission monitoring and time domain reflectometry techniques.

BALANCING

84-2334

Some Results on the Twice-Per-Revolution Balancing of Generators

N. Bachschmid and C. Frigeri

Politecnico of Milan, Italy, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 49-54, 13 figs, 2 refs

Key Words: Balancing techniques, Generators

A procedure is described for the twice-per-revolution balancing of two-pole generators. Twice per revolution vibrations are due to axial asymmetry, which has to be reduced to a minimum by suitable compensating slots. The procedure was applied to a 660 MW generator and the experimental results show that the method was successful.

84-2335

Balancing Flexible Rotating Shafts with an Initial Bend

A.G. Parkinson, M.S. Darlow, and A.J. Smalley
The Open Univ., Milton Keynes, UK, AIAA J., 22 (5), pp 683-689 (May 1984) 9 figs, 10 refs

Key Words: Balancing techniques, Shafts, Flexible rotors, Initial deformation effects

The synchronous whirl of a rotating, flexible shaft induced by an initial bend is similar, though slightly different, than that induced by a pure mass unbalance. The differences are due to differences in the forcing effects produced by these phenomena. A discussion of the problems associated with balancing bent, flexible shafts is presented. Experimental results are reported for a long, flexible shaft which demonstrate the effects of initial bend at speeds up to and beyond the fourth critical speed. Included are the results of a series of very successful balancing tests.

84-2336

A New Method for the Balancing of Flexible Rotors (Ein Neues Verfahren zum Auswuchten elastischer Rotoren)

M. Müller
Ing. Arch., 54 (2), pp 98-106 (1984) 5 figs, 10 refs (In German)

Key Words: Balancing techniques, Flexible rotors, Influence coefficient method

The influence coefficients necessary for the balancing of flexible rotors can be determined with one single measuring run, if rotor vibrations are measured at different bearing stiffnesses. Experiments show good agreement with existing methods.

84-2337

Balancing Experiences of Large Electric Machines for Electric Energy Production

S. Marchetti
Test Room Expert of Large Machines, Ansaldo, Genoa, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 285-295, 4 figs, 1 table

Key Words: Balancing techniques, Motors

Experiences in balancing large electrical machines are reported. Dynamic and boundary effects acting on the vibrating systems are taken into consideration. Different methods of balancing are also investigated.

84-2338

A Unified Approach to Balancing with Multiple Constraints

E.S. Zorzi, C. Giordano, and C. Lee
Mechanical Technology Inc., Latham, NY, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 297-303, 9 figs, 7 refs

Key Words: Balancing techniques, Unified balancing approach

A method is presented which imposes no restrictions on the use of modal trial weight sets and/or modal influence coefficients which have been proven effective for balancing high-speed rotors in previous unified approaches. This new technique overcomes the restrictions of earlier unifying efforts by permitting that constraints be imposed at any speed and not just critical speeds. It provides an analytic extension of the general influence coefficient method and offers a least squares formulation that incorporates the constraints within the optimization procedure. A special test facility is described which has been used to evaluate this approach to balancing.

84-2339

Comparison of Effectiveness of Several Balancing Methods for Flexible Rotors

Z. Shixiang and N.F. Rieger
Henan Power Res. Inst., People's Rep. of China, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 305-316, 9 figs, 8 tables, 7 refs

Key Words: Balancing techniques, Modal balancing technique, Influence coefficient method, Rotors, Flexible rotors

Comparison studies of the effectiveness of four currently used methods for balancing flexible rotors are described. The methods compared are the N-modal method, the N+2 modal method, the modal averaging method, and the influence coefficient method. Two practical rotor systems were used for the studies described – a small gas turbine rotor which operates in rolling-element bearings, and a 300 MW generator rotor in fluid-film bearings. Computer studies of each of the balancing methods mentioned above were made for these rotor systems.

84-2340

Balancing of a Multi-Mass Flexible Rotor-Bearing System without Phase Measurements

E.J. Gunter, H. Springer, and R.R. Humphris

Univ. of Virginia, Charlottesville, VA, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 317-330, 23 figs, 5 tables, 7 refs

Key Words: Balancing techniques, Rotors, Critical speeds

The dynamic characteristics of a vertical three-mass rotor-bearing system were investigated to determine the critical speeds and the stability onset speed of an experimental rotor-bearing test system in which the bearing span could be varied. The location of the observed critical speeds were compared with the values of the predicted critical speeds. The rotor planar modes were compared with the predicted values by exciting the stationary rotor system and observing the frequencies with an FFT-analyzer. In general, excellent agreement was obtained between the predicted and measured values of the critical speeds. Various balancing methods were studied in order to balance the rotor through three critical speeds. These methods included the least squares influence coefficient method of balancing, the modal method of balancing, and the three trial weight method using component modes. This paper presents the three trial weight method of multiplane balancing without the use of phase measurements.

MONITORING

84-2341

Condition Monitoring of Large Francis Turbine and Generators on Hydro Power Stations

J.R.F. Arruda, H.I. Weber, and D. E. Zampieri

Univ. of Campinas - Brazil, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 331-336, 8 figs, 13 refs

Key Words: Monitoring techniques, Hydroelectric power plants, Power plants (facilities), Turbines, Generators

Existing vibration standards have proved to be inefficient for large, low-speed Francis turbines and generators in hydro power plants. Based upon results of a first series of in-situ measurements on 160 MW, 87.5 rpm machines, measurement and analysis procedures are discussed. Bearing mobility compensation of measured vibration is proposed and a straightforward method for evaluation of tilting-pad bearing characteristics is outlined.

84-2342

An On-Line Computer System as an Aid to Solving Rotor Dynamic Problems

A. Curami, M. Gasparetto, V. Rognoni, and F. Di Pasquantonio

Politecnico of Milan, Rotordynamic Problems in Power Plants, Intl. Conf., Intl. Fed. for Theory of Machines and Mechanisms, Tech. Comm. for Rotor Dynamics, Sept 28 - Oct 1, 1982, Rome, Italy, pp 337-345, 5 figs, 9 refs

Key Words: Monitoring techniques, Turbogenerators Power plants (facilities)

A solution to turbogenerator monitoring problems is suggested. It deals with the analogic measure chain along with the A/D conversion techniques and the effective quantities elaboration. After analyzing the quantitites to keep under control, possible acquisition modalities are described in full detail together with the elaboration and the errors coming from each of them during the data collecting and processing. Flow charts and examples which show the program logic are included.

84-2343

Acoustic Emission Monitoring of ZB-1 Intermediate Scale Vessel Test

P.H. Hutton, R.J. Kurtz, and R.A. Pappas

Battelle Pacific Northwest Labs., Richland, WA, Rept. No. PNL-SA-11636, CONF-8310224-1, 17 pp (Oct 1983) (MPA Seminar on Safety of Light Water

Reactor Pressure Vessels, Stuttgart, Fed. Rep. Germany, Oct 13, 1983)
DE84004849

Key Words: Monitoring techniques, Acoustic emission, Nuclear reactors, Pressure vessels

Primary results derived to data from the 70 exp 0 C portion of the testing include: demonstration of the ability of AE to signal an impending failure condition; AE from fatigue crack growth detection using sensing methods directly applicable to reactor monitoring; special features of the AE data; the reliability of AE in detecting cracks during inservice hydrostatic testing; use of AE data to estimate flaw severity; and the pattern recognition method for identifying AE signals from crack growth.

84-2344
Expand Supervisory Function to Include Diagnostics
W.L. Arnold
Bently Nevada Corp., Minden, NV, Power, 127 (12), pp 61-63 (Dec 1983) 5 figs

Key Words: Monitoring techniques, Turbomachinery

Various diagnostic functions of turbomachinery supervisory instrumentation are described, such as continuously measuring absolute shaft motion, shaft position relative to the bearing, monitoring shaft vibration and phase angle measurement.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

84-2345
The Application of Green's Multi-Dimensional Function to Investigate the Stochastic Vibrations of Dynamical Systems
W. Pekala and J. Szopa
The Centre of Res. and Dev. of Machines (OBRUM), 44-101 Gliwice ul. Toszecka 102 Poland, Ing. Arch., 54 (2), pp 91-97 (1984) 7 figs, 31 refs

Key Words: Green function, Random vibration

Green's multi-dimensional function is applied to determine the probabilistic characteristics of the solutions of stochastic linear equations with time-variable coefficients with random initial conditions and random excitations. The method is applied to calculate the variances of solutions for the vibrations of a vehicle model (or suspension) accelerated over a random profile.

84-2346
Normal Modes of a Lagrangian System Constrained in Potential Well
V. Benci
Mathematics Res. Ctr., Univ. of Wisconsin at Madison, Rept. No. MRC-TSR-2610, 32 pp (Dec 1983) AD-A137 948

Key Words: Lagrange equations, Normal modes

The question of existence and the number of periodic solutions (normal modes) for a classical mechanical system is a problem as old as the field of analytical mechanics itself. The development of the nonlinear functional analysis has renewed interest in these problems. This paper considers a mechanical system which is constrained in a potential well.

84-2347
Minimum Weight Design for Structural Eigenvalue Problems by Optimal Control Theory
W. Teschner
Technical Univ. of Darmstadt, Darmstadt, Fed. Rep. Germany, J. Struc. Mech., 11 (4), pp 491-500 (1983-84) 7 refs

Key Words: Eigenvalue problems, Minimum weight design

The application of the optimal control theory to minimum weight design of continuous one-dimensional structural elements subject to eigenvalue constraints is discussed. If not only the value of an eigenvalue is prescribed but also its position in the sequence of the ordered eigenvalues -- for example, the critical buckling load of a column -- the corresponding optimal control problem is shown to include necessarily all eigenvalues. Considering the unspecified eigenvalues as free parameters, necessary conditions for minimum weight design are derived.

84-2348
Eigenvalue Analysis of the Complex Damped Dynamic Systems Discretization by the Use of Finite Element Method
M. Zmindak

Institute of Materials and Machine Mechanic of the Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnicky Casopis, 35 (1-2), pp 195-202 (1984) 1 fig, 1 table, 16 refs
(In Slovak)

Key Words: Eigenvalue problems, Damped systems, Finite element technique

Development of the FEM makes possible further precision of dynamical investigation methods of engineering structures. The derived mathematical model is a set of linear second order ordinary differential equations with constant coefficient matrices of mass of damping and stiffness. The first step in the solution of the mathematical model is the eigenvalue analysis (eigenvalues and eigenvectors) which are dependent only on coefficient matrices. The results of this analysis can be directly used in determination of dynamical properties and simultaneously enable to compute the system response due to excitation.

84-2349

Dynamic Reduction Algorithms for the Structural Eigenproblem

G.H. Sotiropoulos

Univ. of Thessaloniki, Dim. Gounari 5, Thessaloniki, Greece, Acta Mech., 50 (3-4), pp 231-248 (1984) 4 figs, 8 tables, 26 refs

Key Words: Eigenvalue problems

A new dynamic reduction approximation method is presented based on a proper condensation of the dynamic stiffness matrix. Some alternative algorithms are presented and compared; the original transcendental or finite but high-order structural eigenproblem is replaced by a sequence of algebraic ones in an attempt to obtain savings in time and cost over the scanning or counting methods.

84-2350

Torsional Response of an Elastic Half Space to a Nonuniformly Expanding Ring Source

M. Ghosh and M.L. Ghosh

Dept. of Mathematics, North Bengal Univ., Darjeeling - 734430, India, Z. angew. Math. Mech., 63 (12), pp 621-629 (1983) 3 figs, 9 refs

Key Words: Elastic half-space, Torsional response, Impulse response

Exact expressions for displacement in a homogeneous isotropic elastic half-space subjected to an impulsive torsional force spreading over the rim of a nonuniformly expanding ring source on the free surface are obtained in integral form. Both accelerating and decelerating expansion of the source are considered.

84-2351

Surface- and Interface Oscillations of a Rotating Viscous Liquid Column of Immiscible Liquids

H.F. Bauer

Hochschule der Bundeswehr, München, Fachbereich Luft- und Raumfahrttechnik, Munich, Fed. Rep. Germany, Forsch. Ingenieurwesen, 50 (1), pp 21-31 (1984) 6 figs, 23 refs

Key Words: Rotating liquid columns, Liquids, Spacecraft, Natural frequencies

The natural damped coupled frequencies of a rotating viscous infinite liquid column with no axial dependency are determined. The frequency equation is presented for a single liquid column, an annular liquid column around a rotating rigid center core, two immiscible liquids with a free- and interfacial surface and also for two immiscible liquids in a rigid container.

84-2352

A Finite Element Technique for Simultaneously Predicting Upper and Lower Bound Modal Frequencies of Elastic Structural Systems

M.T. Shelton

Ph.D. Thesis, Univ. of Southern California (1983)

Key Words: Boundary value problems, Finite element technique, Rods, Beams

The Lehmann-Maehly method is used to develop finite elements representing uniform rods, tapered rods, simple uniform beams, and simple tapered beams. The method results in a hybrid element formulation where both displacement functions and stress functions at nodal points are treated as degrees of freedom. The finite elements are then used to analyze the longitudinal vibrations of uniform and tapered rods and the transverse vibrations of uniform and tapered beams. The vibration analyses using these new elements predict both upper and lower bounds to the eigenvalues of the vibrating elastic system.

84-2353

Deterministic Identification of Turbulent Loads for General Mechanical Structures with Uncertain State Measurements

J.M. Skowronski

Univ. of Queensland, St. Lucia, Qld. 4067, Australia, Mech. Res. Comm., 10 (6), pp 345-350 (Nov/Dec 1983) 2 refs

Key Words: Aerodynamic loads, Turbulence, Fluid induced excitation, Theory of adaptive identifiers

Atmospheric or water turbulence (persistent gustiness) acting upon a plane, or a ship, or any mechanical structure leads to model consistent with the game-against-nature, where the active player ≡ designer must select a feedback strategy against all the options of the turbulence (≡ passive player). For this problem of simultaneous identification of load and state, at the same time securing the design objectives -- most often a type of stability of the system, the theory of adaptive identifiers is employed. It considers the uncertain state and model parameters given, and constructs an auxiliary system called identifier (predictor), whose states and parameters converge ultimately to these of the model. The required convergence is achieved by securing some type of Liapunov stability of the diagonal set in the Cartesian product of the state-input spaces of our structure and of some nonlinear predictor.

84-2354

Algorithm for Aging Viscoelastic Structures under Periodic Load

Z.P. Bazant and Tong-Sheng Wang

Northwestern Univ., Evanston, IL 60201, ASCE J. Engrg. Mech., 110 (6), pp 972-984 (June 1984) 4 figs, 24 refs

Key Words: Concretes, Viscoelastic properties, Algorithms, Spectrum analysis, Periodic excitation

A numerical step-by-step algorithm for the analysis of concrete structures exposed to a periodic history of environmental humidity or temperature is presented. The proposed algorithm is useful for spectral analysis of the response of concrete structures exposed to random environmental humidity or temperature, and tremendously reduces the computation time when high frequencies are present in the spectral density of environment.

84-2355

Nonlinear Oscillations of Systems with Hysteresis

A. Repaci

Dept. of Mathematics, Politecnico of Torino, Torino, Italy, Mech. Res. Comm., 10 (6), pp 351-357 (Nov/Dec 1983) 4 figs, 16 refs

Key Words: Hysteretic damping, Nonlinear theories

Many physical systems show in their behavior phenomena of hysteresis. These phenomena can be connected with the presence of Coulomb-friction or with elastoplastic behavior of materials forming the system. The aim of the present study is: to obtain an integral equation for calculating the waveform of the forced vibration; to determine the steady state forced vibration in the first approximation of sinusoidal waveform and the corresponding response curves in amplitude and phase; and to discuss the assumed model with energy balance both for forced and for free damped vibrations.

OPTIMIZATION TECHNIQUES

84-2356

A Variational Formulation for Multicriteria Structural Optimization

M.P. Bendsoe, N. Olhoff, and J.E. Taylor

The Technical Univ. of Denmark, DK-2800 Lyngby, Denmark, J. Struc. Mech., 11 (4), pp 523-544 (1983-84) 3 figs, 10 refs

Key Words: Optimization, Minmax technique, Cantilever beams, Beams, Columns

Multicriterion structural optimization problems stated as minimization of the maximum of a set of weighted criteria are considered. Interpretation of the min-max problem as a simple minimization problem for an upper bound on the criteria leads to a formulation that is convenient for analysis of problems with global as well as local objectives. The method is demonstrated on the multipurpose design of a vibrating cantilever, on design of a column for maximum Euler buckling load taking multimodality into account, and on the optimum design of a simply supported beam with respect to compliance and maximum deflection.

84-2357

A Nondifferentiable Optimization Algorithm for Structural Problems with Eigenvalue Inequality Constraints

Y.Y. Wardi and E. Polak

Univ. of California, Berkeley, CA 94720, J. Struc. Mech., 11 (4), pp 561-577 (1983-84) 27 refs

Key Words: Optimization, Eigenvalue problems

This paper presents a nondifferentiable optimization algorithm for solution of structural optimal design problems with eigenvalue inequality constraints. The algorithm is shown to be convergent both in the L_∞ and in the sequence space topologies.

DESIGN TECHNIQUES

84-2358
Shape Design Sensitivity Analysis of Elastic Structures

K.K. Choi and E.J. Haug
Univ. of Iowa, Iowa City, IA 52240, J. Struc. Mech., 11 (2), pp 231-269 (1983) 6 figs, 14 refs

Key Words: Design techniques, Geometric effects, Vibration response, Elastic systems

Design problems in which the shape of two- or three-dimensional elastic bodies plays the role of design are studied. Five prototype problems are formulated in a unified variational form, with performance measures involving natural frequency, displacement, and stress in the structure. Examples are presented for beams, membranes, shafts, and three-dimensional elastic solids.

84-2359
Design Against Wind-Excited Vibration

A. Bolton
Heriot-Watt Univ., Edinburgh, UK, Struc. Engr., 61A (8), pp 237-245 (Aug 1983) 4 figs, 2 tables, 3 refs

Key Words: Wind-induced excitation, Design techniques

This paper sets out a way in which a structural engineer can decide whether a proposed structure would turn out to be dynamically unstable if built on a particular site. When the simple calculations indicate that the structure would, in fact, be wind sensitive, advice is given on ways of entirely avoiding the situation at the design stage instead of allowing a real, and therefore expensive, problem to arise during construction, or after completion.

COMPUTER PROGRAMS

(Also see No. 2255)

84-2360
EISPACK: A Package for Solving Matrix Eigenvalue Problems

J.J. Dongarra and C.B. Moler
Argonne National Lab., Argonne, IL, Rept. No. ANL/MCS-TM-12, 27 pp (Aug 1983)
DE84005408

Key Words: Computer programs, Eigenvalue problems, Matrix methods

This is a two part paper on the software package EISPACK. The first part describes the development and usage of the EISPACK and is intended as an introduction to the package. The second part describes changes made to the package for the current release and how to install the package. EISPACK is a systemized collection of subroutines that compute the eigenvalues and eigenvectors of different classes of matrices.

84-2361
Computer Programs for Seismic Analysis of Piping Systems with Special Reference to the Power Piping Code B31.1

A. Weyn
Centre de Recherches Scientifiques et Techniques de l'Industrie des Fabrications Metalliques, Brussels, Belgium, Rept. No. CRIF-MT-158, 75 pp (Sept 1983)
N84-16601

Key Words: Computer programs, Piping systems, Seismic analysis, Finite element technique

The finite element program CRIF-PIPE was extended with the seismic analysis of three dimensional piping systems. Calculated stresses are compared with American Power Piping Code B31.1 values. Piping system response to an earthquake is computed from the normal mode superposition technique, which requires determination of the system eigenfrequencies and eigenmodes. The program can cope with different response spectra at different sets of foundation points in the piping system. For seismic analysis, the same geometric model can be used as for the static analysis.

84-2362
NASTRAN Forced Vibration Analysis of Rotating Cyclic Structures

V. Elchuri, G.C.C. Smith, and A.M. Gallo

Bell Aerospace Textron, Buffalo, NY 14240, J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 106 (2), pp 224-234 (Apr 1984) 12 figs, 8 refs

Key Words: Computer programs, NASTRAN (computer programs), Blades, Turbine blades, Propeller blades, Fan blades

Theoretical aspects of a new capability developed and implemented in NASTRAN Level 17.7 to analyze forced vibration of a cyclic structure rotating about its axis of symmetry are presented. Fans, propellers, and bladed shrouded disks of turbomachines are some examples of such structures. The capability includes the effects of Coriolis and centripetal accelerations on the rotating structure which can be loaded with directly applied loads moving with the structure and inertial loads due to the translational acceleration of the axis of rotation.

84-2363

Some Considerations on Boundary Integral Equation Method: A Dynamic Program for Two-Dimensional Fracture Mechanics Problems

F.G. Benitez

Oxford Univ., UK, Rept. No. OUEL-1468/83, 111 pp (1983)

N84-16600

Key Words: Computer programs, Fracture properties

The theoretical and numerical bases of boundary integral equation method (BIEM) techniques in real transformed dynamics are presented. Numerical results for impact problems obtained by BIEM with a general applications dynamic program are shown. The numerical integration procedure is described. The computer program is presented.

84-2364

PERUSE: A Numerical Treatment of Rough Surface Scattering for the Parabolic Wave Equation

L.B. Dozier

Science Applications, Inc., 1710 Goodridge Dr., McLean, VA 22102, J. Acoust. Soc. Amer., 75 (5), pp 1415-1432 (May 1984) 6 figs, 8 tables, 48 refs

Key Words: Computer programs, Underwater sound, Conformal mapping, Sound waves, Wave scattering

Scattering of underwater acoustic signals from real ocean surfaces often does not fit into any of the classical theoretical approaches to the problem. Thus the need for a numerical approach is clear. A novel method is presented that uses a sequence of conformal mappings to locally flatten successive segments of the surface, which is assumed piecewise linear and frozen in time. Each conformal mapping preserves the elliptic form of the reduced wave equation, so that in each transformed space the parabolic approximation can be made and the solution advanced one range step using the split-step Fourier algorithm.

84-2365

ABAQUS/EPGEN -- A General Purpose Finite Element Code with Emphasis on Nonlinear Applications

H.D. Hibbitt

Hibbitt, Karlsson, and Sorensen, Inc., 35 S. Angell St., Providence, RI 02906, Nucl. Engrg. Des., 77 (3), pp 271-297 (Feb 1984) 31 figs, 39 refs

Key Words: Computer programs, Finite element technique, Nuclear power plants

ABAQUS, a finite element program designed for general use in nonlinear as well as linear structural problems, is described in the context of its application to nuclear structural integrity analysis. A discussion of the design criteria and methods upon which the code development has been based is presented. The engineering modeling capabilities currently implemented in the program -- elements, constitutive models and analysis procedures -- are described.

84-2366

Hydrodynamic Loading and Response of Reactor Internals Using 3D STEALTH/WHAMSE

F.H. Chang, G.A. Mortensen, G.E. Santee, Jr., M.B. Gross, T.B. Belytschko, and R.N. Oehlberg

Intermountain Technologies, Inc., P.O. Box 1604, Idaho Falls, ID 83401, Nucl. Engrg. Des., 77 (3), pp 251-269 (Feb 1984) 20 figs, 17 refs

Key Words: Computer programs, Interaction: structure-fluid, Nuclear reactors

A three-dimensional methodology was developed for realistically predicting fluid-structure interaction transient loads and the structural response of the reactor vessel, core support barrel, and core during the subcooled portion of a hypothetical loss-of-coolant accident. The methodology uses a

hydrodynamics computer program, STEALTH 3D, coupled with a structural response program WHAMSE 3D, to calculate the hydrodynamic and structural behavior of two tests in a HDR blowdown program in Germany.

84-2367

Computer Program to Model Passive Acoustic Antisubmarine Search Using Monte Carlo Simulation Techniques

S.G. Slaton

Naval Postgraduate School, Monterey, CA, 243 pp (Sept 1983)

AD-A138 352

Key Words: Computer programs, Acoustic detection, Underwater sound, Monte Carlo method

This thesis presents a computer program (written in FORTRAN) which uses Monte Carlo techniques to simulate a one-searcher, one-target passive acoustic ASW search that terminates at detection. A threshold crossing detection model is used, and stochastic variations in the acoustic signal are modeled using either a Lambda-Sigma Jump or Gauss-Markov error process. Both platforms have the capability of detecting each other, and area and barrier searches are modeled. Features of the program include interactive data input, extensive use of graphical displays, and thorough statistical analysis of the results of the simulation.

84-2368

IMAGES: A Digital Computer Program for Interactive Modal Analysis and Gain Estimation for Eigensystem Synthesis

R L. Jones

NASA Langley Res. Ctr., Hampton, VA, Rept. No. L-15655, NASA-TM-85690, 47 pp (Feb 1984)

N84-17186

Key Words: Computer programs, Modal analysis, Modal synthesis

An interactive digital computer program for modal analysis and gain estimation for eigensystem synthesis has been written. Both mathematical and operation considerations are described; however, the mathematical presentation is limited to those concepts essential to the operational capability of the program. The program is capable of both modal and spectral synthesis of multi-input control systems. It is user friendly, has scratchpad capability and dynamic memory, and can be used to design either state or output feedback systems.

GENERAL TOPICS

CRITERIA, STANDARDS, AND SPECIFICATIONS

84-2369

Seismic Upgrade of Building 311

G.E. Freeland and M. Sethi

Lawrence Livermore National Lab., CA, Rept. No. UCRL-89986, CONF-8307113-1, 10 pp (Nov 1983) (World Conf. on Earthquake Engrg., San Francisco, CA, July 21, 1983)

DE84003246

Key Words: Standards and codes, Seismic design, Buildings, Reinforced concrete

Building 311, a two-story, reinforced concrete structure, was originally designed and constructed per the earthquake requirements contained in the 1961 Uniform Building Code. A significant difference exists between today's aseismic building codes for new construction and the 1961 Uniform Building Code. Presented is a unique structural/architectural building upgrade involving external building buttresses, drilled piers, and sophisticated connection details for the earthquake protection of building occupants.

AUTHOR INDEX

TECHNICAL NOTES

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Instability of Laminated Cylinders in Torsion
J. Appl. Mech., Trans. ASME, 51 (1), pp 188-193 (Mar 1984) 3 figs, 1 table, 10 refs

J.H. Lau
Vibration Frequencies and Mode Shapes for a Constrained Cantilever
J. Appl. Mech., Trans. ASME, 51 (1), pp 182-187 (Mar 1984) 1 fig, 5 tables, 3 refs

J.H. Lau
Vibration Frequencies of Tapered Bars with End Mass
J. Appl. Mech., Trans. ASME, 51 (1), pp 179-181 (Mar 1984) 2 figs, 10 tables, 10 refs

J.A. Brandon
Derivation and Significance of Second-Order Modal Design Sensitivities
AIAA J., 22 (5), pp 723-724 (May 1984) 6 refs

J.S. Tomar and R. Jain
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AIAA J., 22 (6), pp 848-850 (June 1984) 2 figs, 1 table, 12 refs

M. Sathyamoorthy
Vibration of Orthotropic Thick Circular Plates
AIAA J., 22 (6), pp 851-854 (June 1984) 4 tables, 6 refs

G. Venkateswara Rao and K. Singa Rao
Supersonic Flutter of Short Panels on an Elastic Foundation
AIAA J., 22 (6), pp 856-857 (June 1984) 3 tables, 7 refs

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Footing Response to Horizontal Vibration
ASCE J. Engrg. Mech., 110 (4), pp 648-654 (Apr 1984) 2 figs, 4 tables, 11 refs

S. Jerath and M.M. Shibani
Dynamic Modulus for Reinforced Concrete Beams
ASCE J. Struc. Engrg., 110 (6), pp 1405-1410 (June 1984) 3 tables, 5 refs

L.W. Bean
Random Combinations of Sine Waves of Equal Amplitude
Appl. Acoust., 17 (4), pp 303-308 (1984) 3 tables

K.M. Letherman
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Appl. Acoust., 17 (3), pp 233-242 (1984) 2 figs, 2 tables, 6 refs

S. Bergamaschi and A. Sinopoli
On the Natural Frequencies of a Stepped Thickness Timoshenko Shaft
Meccanica, 19 (1), pp 75-78 (Mar 1984) 4 figs, 3 tables, 6 refs

H.M. Haydl
Simplified Pipe Whip Dynamics
J. Pressure Vessel Tech., Trans. ASME, 106 (2), pp 213-215 (May 1984) 2 figs, 2 refs

P.W. Carpenter
The Effect of a Boundary Layer on the Hydroelastic Instability of Infinitely Long Plates
J. Sound Vib., 93 (3), pp 461-464 (Apr 8, 1984) 2 figs, 10 refs

CALENDAR

NOVEMBER 1984

14-16 Aeronautical Acoustics, Compiegne, France *(J.F. de Belleval, U.T.C., P.O. Box 233, 60206 Compiegne Cedex, France)*

DECEMBER 1984

3-5 International Conference on Noise Control Engineering [International Institute of Noise Control Engineering] Honolulu, Hawaii *(INTER-NOISE 84 Secretariat, Noise Control Foundation, P.O. Box 3469, Arlington Branch, Poughkeepsie, NY 12603 - (914) 462-6719)*

3-6 Truck and Bus Meeting and Exposition [SAE, Detroit, MI *(SAE Hqs.)*

9-14 ASME Winter Annual Meeting [ASME] New Orleans, LA *(ASME Hqs.)*

13-14 Underwater Acoustic Calibration and Measurements, Bracknell, Berks. UK *(L. Lipscombe, db Instrumentation Ltd., Eastern Road, Aldershot, England)*

28-31 International Conference on Applied Numerical Modeling/Computational Mechanics, Tainan, Taiwan, ROC *(S.Y. Wang, Engineering, University of Mississippi, University, MS 38677)*

JANUARY 1985

22-24 Annual Reliability and Maintainability Symp. [IES] Philadelphia, PA *(IES Hqs.)*

29-Feb 1 International Conference on Nondestructive Evaluation in Nuclear Industry, Grenoble, France *(J.P. Launay, COFREND, 32 Boulevard de le Chapelle, 75880 Paris Cedex 18, France)*

FEBRUARY 1985

25-Mar 1 International Congress and Exposition [SAE] Detroit, MI *(SAE Hqs.)*

MARCH 1985

18-21 30th Intl. Gas Turbine Conf. and Exhibit [ASME] Houston, TX *(Intl. Gas Turbine Ctr., Gas Turbine Div., ASME, 4250 Perimeter Park South, Suite 108, Atlanta, GA 30341 - (404) 451-1905)*

APRIL 1985

8-12 Acoustical Society of America, Spring Meeting [ASA] Austin, TX *(ASA Hqs.)*

15-17 Institute of Acoustics Spring Conference [IOA] York University, UK *(IOA, 25 Chambers St., Edinburgh EH1 1HU, UK)*

15-19 2nd Symp. on Interaction of Non-Nuclear Munitions with Structures [Tyndall AFB, FL; Eglin AFB, FL; Kirtland AFB, NM] Panama City Beach, FL *(Ms. L.C. Clouston, Registrar, P.O. Box 1918, Eglin AFB, FL 32542 - (904) 882-5614)*

22 ð International Symposium on Acoustical Imaging, The Hague, The Netherlands *(J. Ridder, P.O. Box 5046, 2600 GA Delft, The Netherlands)*

29-May 3 31st Annual Technical Meeting and Equipment Exposition [IES] Las Vegas, NV *(IES Hqs)*

MAY 1985

6-8 4th International Symposium on Hand-Arm Vibration [Finnish Institute of Occupational Health] Helsinki, Finland *(I. Pyykko, Institute of Occupational Health, Laajaniityntie 1, 01620, Vantaa 62, Finland)*

6-9 American Society of Lubrication Engineers, 40th Annual Meeting [ASLE] Las Vegas, NV *(ASLE Hqs.)*

JUNE 1985

3-5 NOISE-CON 85 [Institute of Noise Control Engineering and Ohio State University] Columbus, OH *(NOISE-CON 85, Dept. of Mechanical Engineering, Ohio State University, 206 W. 18th Ave., Columbus, OH 43210 - (614) 422-1910)*

JULY 1985

2-4 Ultrasonics International '85, Kings College, London *(Z. Novak, Ultrasonics, P.O. Box 63, Westbury House, Bury Street, Guildford, Surrey GU2 5BH, England)*

11-13 International Compressor Engineering Conference, Lafayette, IN *(Purdue University, W. Lafayette, IN - (317) 494-2132)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASLE: American Society of Lubrication Engineers
838 Busse Highway
Park Ridge, IL 60068

ASME: American Society of Mechanical Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

ICF: International Congress on Fracture
Tohoku University
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IMechE: Institution of Mechanical Engineers
1 Birdcage Walk, Westminster,
London SW1, UK

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
67 Alexander Dr.
Research Triangle Park, NC 27709

SAE: Society of Automotive Engineers
400 Commonwealth Dr.
Warrendale, PA 15096

SEE: Society of Environmental Engineers
Owles Hall, Buntingford, Hertz,
SG9 9PL, England

SESA: Society for Experimental Stress Analysis
14 Fairfield Dr.
Brookfield Center, CT 06805

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
Naval Research Laboratory
Code 5804
Washington, D.C. 20375

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PUBLICATION POLICY

Unsolicited articles are accepted for publication in the **Shock and Vibration Digest.** Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress *important recent* technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in DIGEST articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the example below.

> *Unfortunately, such information is often unreliable,* particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and the practical applications that have been explored [3-7] *indicate that . .*

The format and style for the list of References at the end of the article are as follows:

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- last name of author/editor followed by initials or first name
- titles of articles within quotations, titles of books underlined
- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
- volume, issue number, and pages for journals; publisher for books
- year of publication in parentheses

A sample reference list is given below:

1. Platzer, M.F., "Transonic Blade Flutter - A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).

2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addison-Wesley (1955).

3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Dev. (1962).

4. Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).

5. Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).

6. Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnel," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).

7. Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).

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